POWER

Established 1884—McGraw-Hill Publishing Company, Inc.

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VOLUME 77 MAY, 1933 NUMBER 5

NO MORE EGGS

• HOMELY WISDOM is wrapped up in such old fables as that of the man who killed the goose that laid the golden eggs. He found no gold in the goose and his egg supply stopped.

• TODAY THAT GOOSE is the manufacturer of power equipment who for years has been laying the golden eggs of broad service and improved products. He is put on the block by those who do not know *enough* when they see it—"chiselers," in plain American.

• OF CHISELERS there are 57 varieties, and most of us qualify. Here are four samples:

• BY THREATS and tricks, industrial buyers use a bottom price as a top. Buying below cost becomes a matter of routine.

• "GYP" MANUFACTURERS find soft spots in established lines of power equipment. With cheap labor and second-hand machinery, they break the market on the "easy run" sizes, leaving the established manufacturer to sweat under the profitless burden of readiness to render a complete and well-engineered service.

• NATIONAL BUYING ORGANIZATIONS comb the country for distress markets. Abnormal lows found here and there are then set up as the standard to which prices everywhere must be clubbed.

• AS SILENT PARTNERS in chiseling, cities, states and the national government award big contracts to bidbrokers disguised as "general contractors." These gentlemen do not fit their bids to the cost, but do the reverse. The bid is trimmed to win the job, then sub-contractors are trimmed to fit the bid. And sometimes, it is whispered, the sub-contractor trims quality to save his shirt.

• THESE ARE JUST SAMPLES, typical from Atlantic to Pacific. It's mighty bad medicine for the manufacturer whose years of engineering and service count for nothing in the mad scramble for price.

• NOR WILL HE SUFFER ALONE. "The man who pays the piper calls the tune," but you can't get sweet music for a penny. Stability, service, engineering, product quality—all those things most prized by the wise buyer of power equipment—rest on a foundation of profit. If profit is withdrawn, the structure falls.

• POWER MEN, as users and buyers of equipment, must now face this problem squarely. Do they or do they not value those things that have contributed so greatly to cheaper and better power service? Do they or do they not desire an unobstructed road to continued power progress? If they do, they must pay the price—a minimum living wage for the reputable equipment manufacturer.

• NOT ONLY THAT; the power engineer, as a salaried executive, is part of an industry that sells, as well as buys. He, too, through pay cuts made necessary by profitless business, is a victim of the chisels. As a player on both teams he may as well call quits on the game that never was worth the candle.

"Rush by Express"

● Johnny's pants are dropping off—buttons all gone. For three years, management, trying to be Scotch, has been robbing idle power machines of odd parts until some of them are junk, cheaper to replace than repair. The policy of living on nothing a year has gone its limit. Spare capacity is derelict; operating machines limp.

Already trouble is popping. The stream of wired orders, "Rush Parts by Express," is steadily growing. Telegraph and express companies are getting the "savings" that were laid aside for rainy days.

The time has come to be realistic—to stock shelves with a minimum of essential spare parts shipped by freight—to renew or replace the reserve power units for their intended purpose.

A man may fast for a while and still breathe, but he cannot live forever off his own fat.

Placard the Losses

● Here is an idea for the power engineer saddled with an executive who won't spend to save because he can't see the savings. Hand him, say, a report of boiler operation, but not in the conventional form. Title it "Coal Wasted in April." Put the figures in two columns—tons and dollars. Run three lines: "Coal to make steam," "Coal wasted," "Total coal burned." Just this and nothing else; no B.t.u.'s or efficiencies, no technical data, no comments of any sort.

Sign your name, hand the document in and wait for a call to the carpet. "What about this 167 tons of coal you wasted last month?" Then you can explain to a man who is ready to listen.

Thrift with Steam

● From time to time *Power* has recorded forward steps in the evolution of R. H. Macy's plant, which serves New York's greatest department store. This issue announces another, significant in many ways. To a plant combining steam engines, diesels, air conditioning, Macy's adds a 1,000-kw. condensing turbine served by roof cooling towers.

Following shortly a similar installation at the Newark (N. J.) Evening News (*Power,* Oct. 1932, page 176), this is significant; Macy's has always applied to its own power problems the same canniness that has won it pre-eminence in profitable store operation.

It seems clear that condensing turbines with modern cooling towers are winning an unexpected place in the field of building power. They are unlikely to replace engines generally, but have a place in the heat balance to cut summer steam load.

Steam—Rinsed and Wrung

● To get soap out of socks, Aunt Jemima wrings them, souses them in clear water, then wrings them again. The chemist does the same thing when he purifies a precipitate by "decanting." Now the same idea is being applied with great success to cleanse dirty steam in the South Amboy (N. J.) 1,400-lb.-steam central station.

A scrubber separator within the boiler drum operates in three steps: First, it separates most of the concentrated entrained water; second, flushes the steam with distilled water; third, separates most of this. Result: exit steam contains a very small percentage of very pure water, so that solid carryover practically vanishes.

A big step forward, with even greater possibilities for industrial plants, where high makeup aggravates the carryover problem!

Ahoy Chicago!

● The mariner who sails west today across the lake from lower Michigan finds a dream city rising on his Illinois horizon—a "Century of Progress" housed in metal and glass around a great lagoon.

Predominantly scientific in its spirit and exhibits, Chicago's second great exposition is proper setting for "Engineers Week," June 25 to 30. A.S.M.E., A.S.R.E., N.D.H.A. and other engineering groups will hold sessions, which *Power* will report for practical readers everywhere.

Many who now find themselves in a rut will shine up the old family car for a trip to Chicago, there to win new ideas and a new lease on life.

POWER Stands for

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of By-product Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

BECAUSE "IT'S *SMART* TO BE THRIFTY"—

MACY'S INSTALLS

a 1,000-kw. Mixed-Pressure

TURBINE

Addition of the new turbine and cooling towers will bring capacity of the Macy power plant to 8,500 hp. and will save $40,000 per year in operating cost. Cost of power-plant operation in 1932 was $122,600 less than estimated cost of purchased power and steam

DURING the last ten years, R. H. Macy & Co. has more than doubled the merchandising facilities of its department store at 34th St. and Broadway, New York City, and has extended its power plant to meet these requirements. Confident that the future will require still greater facilities, that company is again increasing power-plant capacity by installing a 1,000-kw. mixed-pressure turbine generator. Installation of this equipment might have been postponed indefinitely, but the work is being done now, when costs are low and there is great need for new construction to increase employment and buying power.

For a detailed description of Macy's power plant up to the installation of the steam turbine, see the leading article in *Power,* July, 1932. Chief features of this expansion are an increase in boiler capacity by changing from coal to oil firing in 1922; later an additional boiler was installed. The boiler plant now consists of 11 oil-fired boilers having a total heating surface of 30,000 sq. ft.

When the change was made to oil firing, power generating capacity was increased from 2,000 to 2,600 kw. Later an additional 750-kw. engine-driven generator was installed, making an aggregate of 3,350 kw. in steam-engine driven generators. An air-conditioning system installed in 1928, operated by exhaust-steam turbines, added 810 hp. to the plant. Power demands continued to increase, and in 1930 two 700-kw. diesel-engine driven units were put into operation. These gave the plant a usable generator capacity of 4,750 kw.

During the last two years, power requirements of the store have been so great that in November and December the plant operated at nearly full capacity. There are tenants on the ground floor of the store that were in the Seventh Avenue building when it was taken over by Macy's. These tenants were served by street power, but it was desirable that they be supplied from the building power plant. This called for an increase in capacity.

Satisfactory and reliable operation of the two exhaust-steam turbines driving the air-conditioning-system compressors and a change in New York City's Building Code that permitted cooling towers on the store roof led to a study, by the engineers in the plant's operating department, to utilize the remaining available exhaust for power generation. It was found that a turbine operating condensing with cooling towers would be the most advantageous power plant enlargement. It was also decided that cooling towers should be installed for the two turbines driving the air-conditioning-system compressors, as a large waste in clean water could be eliminated.

Werner Nygren and Kaiser, Muller & Davies, consulting engineers, were then employed to check the Macy engineers' estimates and to handle engineering design and construction work. As can be seen from the heat-balance diagram, Fig 1, over 40 per cent of the yearly exhaust steam from the present plant is discharged to

atmosphere. Over one-half of this will be available for power generation, the total amount being reduced in proportion to engine load replaced by the turbine.

An important consideration in selecting a steam turbine was that it allowed installing the greatest amount of capacity in the space available. When the turbine is installed, power generating capacity will have been increased from the original 2,000 to 5,750 kw. without going outside the original power-plant walls.

Water used for the air-conditioning system and in the diesel-engine jackets, that each year cost about $10,000, had to be wasted to the sewer. Practically all of this waste will be eliminated by installing cooling towers.

The foregoing considerations and a conservative estimate that showed a saving of $40,000 per year could be made in plant operating costs by installing the turbine and cooling towers led to the decision in their favor. When these equipments are in operation, practically no low-pressure steam will go to atmosphere or clean water to the sewer. It is estimated that the savings in plant operation and from other sources will pay for the new installation in four years.

The De Laval turbine will operate at 5,340 r.p.m. and will be geared to a single 1,000-kw. Crocker Wheeler generator. There are five stages in the turbine. The first or high-pressure stage has two rows of buckets and the others have a single row. The turbine will be operated in three ways: on exhaust steam only, on high-pressure steam only and on a combination of the two.

Exhaust steam at 1-lb. pressure will be admitted between the first and second stages. When operating in this way the turbine will have a rating of 1,000 kw. and a guaranteed water rate of 32.2 lb. per kw.-hr., when exhausting to a 27.5-in. vacuum. When operated on high-pressure steam only, at a pressure of 140 lb. and ½ per cent of moisture, the turbine is guaranteed to develop 1,250 kw. and have a water rate of 17 lb. per kw.-hr. when the vacuum is 27.5 in.

Normally the turbine will operate on low-pressure steam at about 1-lb. gage pressure. If there is not sufficient exhaust steam and the pressure drops to 0-lb. gage, the governor will admit high-pressure steam at the first stage. The governor control of the turbine is guaranteed to change from full-load on exhaust steam at 1-lb. gage to full load on high-pressure steam without pulling a vacuum on the exhaust steam main.

Five cooling towers will be installed on the roof of the older part of the store, which is 10 stories high. Two of the towers will serve the 1,000-kw. turbine and three the two turbines driving air-conditioning compressors. Space is allowed for a sixth.

These towers are 22.6 ft. square by 32 ft. high. The two for the new turbine are rated at 2,700 g.p.m. of water, cooled from 106 to 81 deg. F. The three that serve the air-conditioning system turbines are rated 2,360 g.p.m. cooled from 109 to 78 deg. F. These ratings are based on summer conditions, with an outdoor wet-bulb temperature of 71 deg. F.

These towers are designed to be especially suitable to conditions encountered in cities. They are compact, fireproof and silent in operation and throw off no mist that would be objectionable to occupants of surrounding buildings. To conform with the fire laws the tower shells are of metal construction, copper-bearing steel plate being selected for low cost and permanence. The interior, including the distribution system, spray eliminators and filling, is of California redwood. The filling is readily removable to make the interior accessible for periodic painting required of the steel work.

In horizontal cross-section, the working portion of each tower is square, but the shell reduces to a circular fan ring at the top. A large four-blade- propeller-type fan is mounted directly on the shaft of a totally enclosed, vertical, geared motor. The motor is designed to operate at a speed of 1,800 to 600 r.p.m. and fan speed will range from 312 to 104 r.p.m.

The motor is supported upon a pipe column that also serves as a riser pipe to carry water from the tower bottom to the distribution system. Between the fan and filling are placed spray eliminators that remove suspended moisture.

Figs. 2 and 3 show the type of construction used in the cooling towers and how they operate. Circulating water from the condensers is pumped to the top of the towers, where it is distributed by an arrangement of troughs. Spaced along the bottom of the troughs are nozzles *N* to direct the water downward onto splash plates *P*, Fig 2. These splash plates spray the water over the top of the wooden filling, whence it trickles in fine streams down through the towers. As the streams fall they are broken up by striking other filling bars at various levels, so that all of the water is brought into intimate contact with air rising up through the tower. The direction of the air currents is indicated by the curved arrows. A section of filler construction of a tower similar to those being installed at Macy's is shown in Fig. 3.

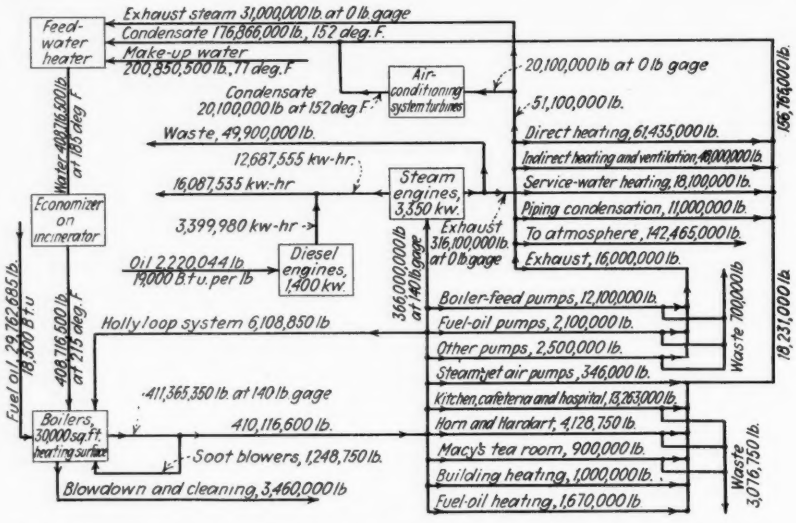
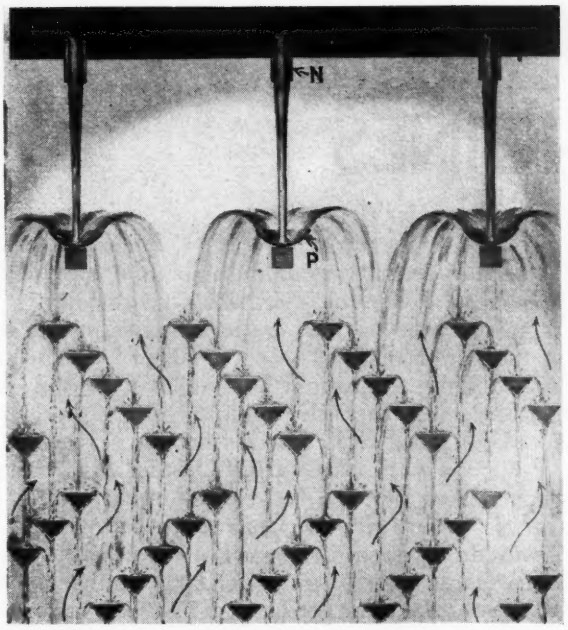

Exhaust steam 31,000,000 lb. at 0 lb. gage
Feed-water heater
Condensate 116,866,000 lb., 152 deg. F.
Make-up water 200,850,500 lb., 71 deg. F.
Air-conditioning system turbines
20,100,000 lb at 0 lb gage
Condensate 20,100,000 lb at 152 deg. F.
51,100,000 lb.
Direct heating, 61,435,000 lb.
Indirect heating and ventilation, 46,000,000 lb.
Service-water heating, 18,100,000 lb.
Piping condensation, 11,000,000 lb.
To atmosphere, 142,465,000 lb.
Exhaust, 16,000,000 lb.
196,766,000 lb.
Waste, 49,900,000 lb.
12,687,555 kw-hr.
16,087,535 kw-hr
Steam engines, 3,350 kw.
3,399,980 kw-hr
Economizer on incinerator
Diesel engines, 1,400 kw.
Oil 2,220,044 lb 19,000 B.t.u. per lb
Exhaust 316,100,000 lb. at 0 lb gage
366,000,000 lb at 140 lb gage
Boiler-feed pumps, 12,100,000 lb.
Fuel-oil pumps, 2,100,000 lb.
Other pumps, 2,500,000 lb.
Steam jet air pumps, 346,000 lb.
Kitchen, cafeteria and hospital, 13,263,000 lb.
Horn and Hardart, 4,128,750 lb.
Macy's tea room, 900,000 lb.
Building heating, 1,000,000 lb.
Fuel-oil heating, 1,670,000 lb
Waste 3,076,750 lb.
Waste 700,000 lb
18,231,000 lb.
Water 408,716,500 lb at 185 deg. F
408,716,600 lb at 218 deg. F
Fuel oil 29,762,685 lb. 18,300 B.t.u.
Holly loop system 6,108,850 lb
411,365,350 lb. at 140 lb gage
410,116,600 lb.
Boilers, 30000 sq. ft. heating surface
Soot blowers, 1,248,750 lb.
Blowdown and cleaning, 3,460,000 lb

Fig. 1—Approximate yearly heat balance diagram for the plant during 1932. Practically all the high-pressure steam quantities are metered, but the low-pressure services are based on estimates made in engineering studies of the different requirements

On the 1,000-kw. turbine the condenser is of the surface type having 3,500 sq. ft. of cooling surface of two-pass design. Steel tube sheets are used with ⅝-in. Muntz metal tubes expanded into both tube sheets. Expansion and contraction of tubes is taken care of by a steel dia-



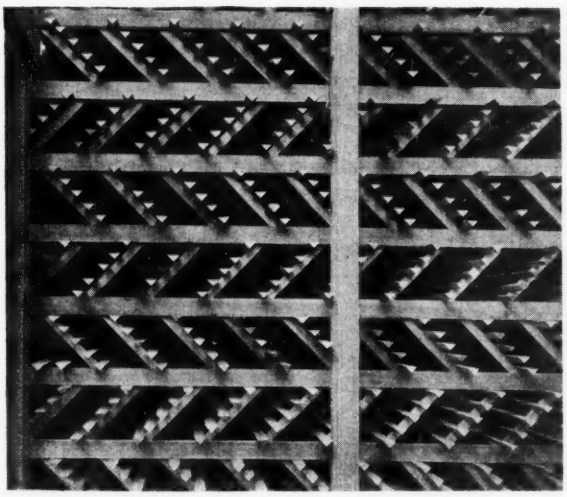


Fig. 2 (Top)—Water distribution system in a section of a cooling tower. Fig. 3—Filler construction in a section of a cooling tower

phragm. This diaphragm is bolted to the condenser shell and supports the tube sheet at the return water-box end. The condenser is guaranteed to condense 35,000 lb. of steam per hour and to give a vacuum of 28.59 in. with 60-deg. cooling water and 27.41 in. of vacuum with 80 deg. F. water. A feature of this condenser is that its water boxes are designed for a pressure of 100 lb. per sq. in. to take care of head up to the cooling towers.

A 2,700-g.p.m., at 60-ft. head, circulating pump driven by a 60-hp. motor serves the condenser. This pump is designed for 150-ft. static pressure. The condenser is also provided with a single-stage centrifugal condensate pump and a two-stage steam-ejector type air pump. On the condensers for the air-conditioning-system turbines two 1,650-g.p.m., 140-ft. head, centrifugal circulating pumps are provided. These pumps are driven by 50-hp. motors.

The condenser on the main turbine with its auxiliary equipment, the circulating pumps on the air-conditioning-system turbines and the five cooling towers are being supplied by the Foster-Wheeler Corporation.

When the power additions were being made a new Cochrane feed-water heater, rated at 150,000 lb. per hr. was installed.

The table and heat-balance diagram give the principal items in plant operation for 1932. Last year a total of 411,365,350 lb. of steam was produced and 16,087,535 kw.-hr. generated. Of this power, 78.8 per cent was supplied by steam units and 21.2 per cent by diesel engines. The low diesel fuel rate of 0.653 lb. per kw.-hr. compared to 2.22 for the steam engines has had a marked effect on plant economy. In 1924 the fuel rate was 2.79 lb. of oil per kw.-hr. By 1928 the rate had decreased to 2.43 lb., and last year the combined fuel consumption of the steam and diesel plant for power generation was 1.99 lb. of oil per kw.hr. This is equivalent to a decrease of 28.7 per cent from the 1924 fuel consumption.

The low cost at which power and steam was supplied is a feature of the plant. Last year the total cost for power and steam for all purposes was $251,663.02. This figure includes $19,877.88 rental charge for the space occupied by the generating plant and $67,000 depreciation and interest charges. There is also included all labor and other charges that could be saved if the plant were shut down.

If power had been purchased for the low average rate of 1.53 cents per kw.-hr. it would have cost $246,197.88, which is only $5,465.14 less than the total cost of supplying both power and the steam for heating purposes. Most high-pressure steam services are metered, so that these are accurately known. The low-pressure steam for heating the building and other purposes has been estimated on several occasions by consulting engineers. Using these figures and those for the high-pressure services that would be required if the plant were shut down, the cost of purchased steam at 72.5c. per 1,000 lb. would be $127,994.40. This gives a total saving of 127,994.40—5,465.14 = $122,529.26 from operating the plant.

From the heat-balance diagram it will be seen that the estimated yearly exhaust now going to the atmosphere is 142,465,000 lb. When the turbine is in operation, very little exhaust will be wasted. Because of this and other economies that will result when the turbine is operated on high-pressure steam, about 25 per cent further reduction in fuel consumption is expected.

For assistance in the preparation of this article, acknowledgment is made to John J. Cogan, engineering counselor and Fred Blume, power-plant statistician for Macy's and Frank Kane, mechanical engineer, Werner Nygren, consulting engineers.

Résumé of Plant Operation in 1932

	1932
Total steam produced, lb.	411,365,350
Fuel oil burned, lb. (boilers)	29,762,685
Heat value of fuel oil, B.t.u. per lb.	18,500
Water evaporated per lb. of fuel, lb.	13.82
Boiler and furnace efficiency, per cent	75.5
High-pressure steam used for building, heating and miscellaneous purposes, lb.	38,007,750
Steam used in engines, lb.	366,000,000
Kilowatt-hours generated by steam	12,685,555
Steam at 140-lb. gage, no superheat, lb. per kw.-hr.	28.8
Fuel oil per kilowatt-hour, lb.	2.220
Fuel consumed by diesel engines, lb.	2,220,044
Kilowatt-hours generated by diesel engines	3,399,980
Oil per kilowatt-hour, lb.	0.653
Cost per kw.-hr., steam and diesel, including all operating charges, interest, depreciations and insurance, but without giving any credit for exhaust steam for heating and power, cents	1.331
Exhaust steam, building heating, lb.	109,435,000
Exhaust steam, air-conditioning plant turbines, lb.	20,100,000
Exhaust steam, service-water heating, lb.	18,100,000
Exhaust steam for feed-water heating, lb.	31,000,000
Live steam brine pumps, heating and cooking, lb.	18,009,000
Condensation in steam pipes, lb.	11,000,000
Estimated cost of purchasing power at 1.53c. per kw.-hr.	246,197.88
Estimated cost of purchasing steam to replace that used for heating and air-conditioning-plant turbines at 72.5c. per 1,000	$127,994.40
Cost of power and steam from Macy's plant	251,663.02
Estimated savings from operating the plant	$122,599.76

WATER WHEEL GOVERNING Principles Applied To DIESEL ENGINES

DIFFICULTIES of governing water wheels to meet changing load conditions have led to much research and development work. This has naturally resulted in advancement of the art of water wheel governing to a point which has not been approached in governing other prime movers. But, year by year, speed control is assuming increasing importance in industry and consequently in power equipment for industry. Many production processes are inherently dependent upon constant frequency for satisfactory results; others require extremely close voltage regulation or constant speed in their prime movers.

The popularity of the diesel has sometimes suffered from lack of such speed control. Consequently many manufacturers, both of diesels and of governors, have been experimenting to find some sort of satisfactory solution. Engineers of Woodward Governor Company have carried on experiments leading to adaptation of the principles of that company's standard water wheel governor for use with diesel engines, and are planning to adapt it further for other types of prime movers.

For those unfamiliar with this type of governor, a short description may be helpful. It consists primarily of a control unit, power unit and oil pressure unit. The control unit is composed of a sensitive governor head driven from the engine shaft, a compensating device that corrects the action of the power mechanism to meet a change in load, a load indicator, a load limit control, an adjustment to permit varying the amount of speed droop, and one for varying unit speed for synchronizing.

Pilot valve, servomotor and mechanical linkage comprise the power unit. The pilot valve is mechanically connected with the governor head and hydraulically with the servomotor. The valve is of the sleeve type, finely balanced for sensitivity. The servomotor is the familiar oil cylinder with close-fitting piston, driving the mechanical linkage to the fuel control mechanism.

The oil pressure unit includes a rotary gear type pump, positively driven from the engine shaft, a spring-loaded relief valve and a sump tank which contains the governor oil and forms the governor base. The relief valve maintains the oil pressure constant, and this force is used by the pilot valve to control the servomotor.

Such a governor can respond to a speed change of less than 1/100 of 1 per cent, and is accurately compensated to be dead beat and to operate without hunting for all values of speed droop and load. While the usual diesel engine governor has an inherent speed droop of 3-6 per cent, this unit is basically isochronous, which means that it maintains the same speed from no load to full load. It is capable of operating alone without speed droop or regulating without speed droop in parallel with other types of governors (providing the load fluctuations are not greater than the capacity of the engine it is controlling), taking all the regulation and maintaining commercially accurate time.

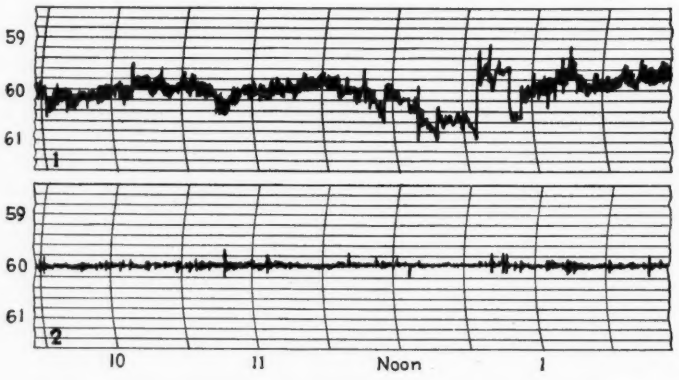
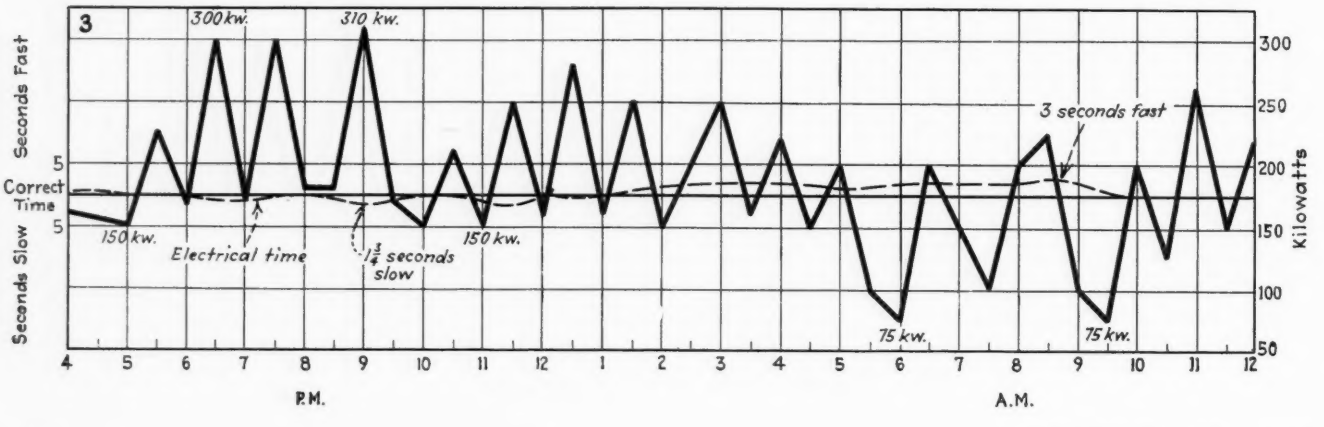


Chart 1—Frequency chart taken on an isolated factory load, with sharp, frequent and heavy load changes ranging from 50 to 800 hp. Four diesels totalling 2,165 hp. equipped with conventional diesel governors

Chart 2—Frequency chart on the same load, with the 1,225-hp. diesel equipped with isochronous governor, the 500-, 300- and 140-hp. units operating with conventional governors. Variations have been reduced materially

Chart 3—Plotted time-keeping results of an isochronous governor controlling a 420-hp. engine on a 20-hr. test run. Governor adjusted for zero speed droop and correct frequency at beginning of run, not touched thereafter. Load variation covers practically entire engine range



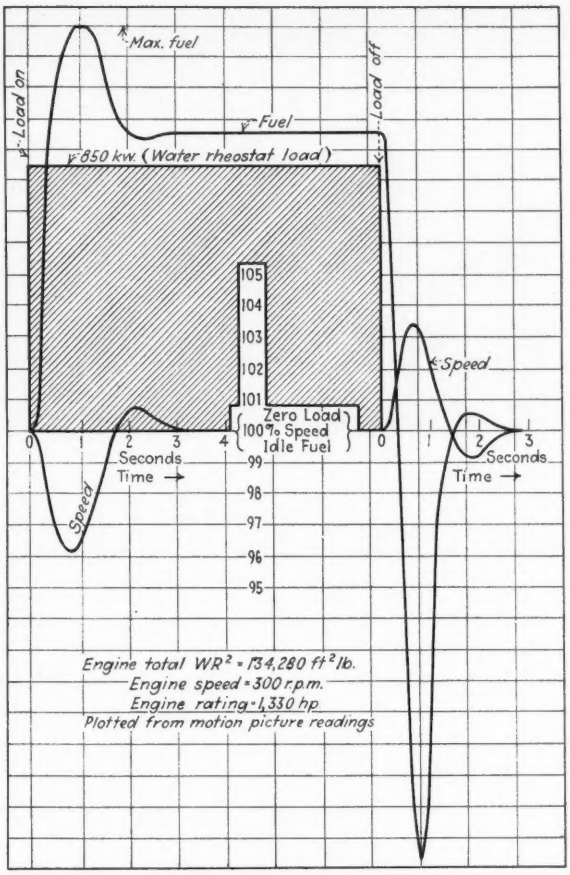


Chart 4—Resulting maximum instantaneous speed change for instantaneous load changes of about 100 per cent. Only one speed oscillation occurs and speed returns to normal in about 3 sec.

If it is desired to divide the load and regulation proportionally between two or more engines equipped with this type of governor, the amount of speed droop required will be less than 0.5 of 1 per cent. If used in parallel with other types of governors, speed droop may be adjusted to the maximum required by the other governors. A load indicator, a synchronizer and an adjustable dial indicating load limit and speed droop are provided to maintain any desired operating program. Adjustments for these elements are ordinarily manual, but may be electrically remote controlled when desired.

Charts 1 and 2 were taken on an isolated factory load, with load changes ranging from 50 to 800 hp. of unusual frequency, sharpness and magnitude. Total prime mover capacity was 2,165 hp., made up of diesel engines of 1,225, 500, 300, and 140 h.p. Chart 1, showing resulting instantaneous and average frequency regulation, was taken with each engine equipped with the conventional type of diesel governor having 5 per cent inherent speed droop. Chart 2 shows similar regulation, with the 1,225 hp. diesel equipped with a Woodward isochronous governor.

Chart 3 shows plotted time-keeping results of a Woodward isochronous governor controlling a 420-hp engine

Chart 4 shows resulting maximum speed change for an instantaneous load change of approximately 100 per cent. Only one speed oscillation occurs and speed returns to normal in less than 3 sec. when load goes off. The regulating constant of the engine and generator in this case equals approximately nine million, and the governor was operating on zero speed droop.

$H_2 + O =$ New Power

SINCE publication of the description of the Erren hydrogen engine (*Power,* Feb., page 90) a number of requests have been received for further information on the engine and on the high-pressure electrolyzers suggested as a means of obtaining the hydrogen at off-peak periods. The following is taken from a paper by Mr. Erren and W. Hastings Campbell before the Institute of Fuels (British).

Public information on high-pressure electrolyzers became available in 1928 when Dr. J. E. Noeggerath read a paper before the German technical societies (abstracted in *Chemical & Metallurgical Engineering,* July, 1928). This electrolyzer is of the diaphragm type, arranged so that complete separation of the two gases is effected. The electrolyte is a 23 per cent solution of KOH. The cell is enclosed and the pressure allowed to rise as far as desired, in some cases to 1,000 atmos. Suitable working pressures are 5,000 to 7,500 lb. per sq. in. Temperature does not rise above 104 deg. F., and the standard machine consumes 0.12 kw.-hr. per cu. ft. of H_2 and 0.014 cu. ft. of O_2 at 60 deg. F. and 14.7 lbs. abs. This remarkable efficiency results from reduction of polarization because of the small bubbles formed at high pressures, and this also reduces the internal resistance of the cells.

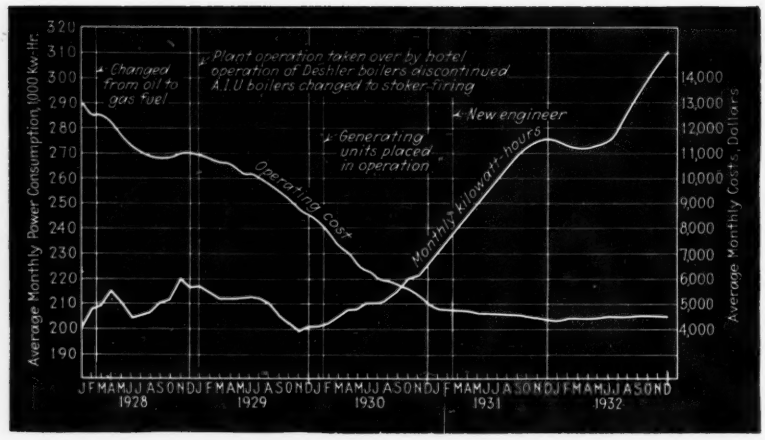
Such an electrolyzer takes up very little space and can be installed out-of-doors if desired. One plant in Germany has been working in the open for six years. Depreciation is low. Principal difficulty is the necessity of disposing of oxygen produced. It is usually saleable.

Hydrogen can be used as fuel in a number of ways: in the hydrogen-air engine, oxy-hydrogen engine, as a "promoter" in internal-combustion engines, as a primer in diesel engines, and in the oxy-hydrogen steam boiler. The hydrogen-air engine has the advantage of requiring only hydrogen storage bottles, thus reducing weight per hp. and fitting it for motor transport. But the oxy-hydrogen engine has its advantages in driving mine locomotives, submarines, and as peak-load equipment in power plants. This engine is literally an internal-combustion steam engine, and by arrangement of the hydrogen inlet valve can be made to give the characteristic diagram of the Rankine cycle.

When used as a "promoter" in internal combustion engines, hydrogen makes it easy to burn fuels ordinarily difficult to burn, such as crude alcohol. There is also a decided increase in thermal efficiency. With diesels, hydrogen used as a priming charge cuts down fuel consumption, and in the Erren diesel the increase in efficiency is sufficiently great to justify installation of a small electrolyzer taking part of the engine output. Further, the engine can be arranged to permit the stored gases to be burned as a fuel if desired—as in submarine or tunnel engines.

Finally, there is the use of the gases in an oxy-hydrogen boiler. If water is atomized by a stream of hydrogen mixed with oxygen and the gases ignited, steam is formed at high pressure, superheated to the degree desired by controlling the water inlet. Output is controlled automatically, and there is no need for flues or ashpits. Such a boiler could be used to carry surplus power in central stations, generating steam for use in existing turbines and maintaining a more steady coal boiler performance.

Costs DOWN 2/3 Kw.-hr. load UP 1/3



—THE RECORD AT DESHLER-WALLICK

A TWO-THIRDS cut in operating costs despite a one-third increase in electrical energy consumption over the past five years is the record for the plant serving the Deshler-Wallick Hotel and the adjoining 47-story office building of the American Insurance Union in Columbus, Ohio. The curves show the combined average monthly cost on a yearly basis for these services in both buildings and the average monthly kilowatt-hours of electric energy consumed. Operating costs, including cost of electric energy, purchased fuel and labor, have dropped from about $13,000 a month to $4,460 a month, while monthly electric energy consumption has increased from about 210,000 kw.-hr. to 310,500 kw.-hr. This decrease in cost is due largely to the combining of the plants and load requirements of the two buildings, and the foresight of the managements of both buildings in seeing the advantages.

In 1928 the plant serving the Deshler portion of the hotel contained two hand-fired, down-draft Scotch marine boilers of about 8,000 lb. of steam per hour capacity at 135-lb. pressure. Steam was used for building and water heating, operating water pumps, brine pumps and a 25 and a 45-ton engine-driven CO_2 compressors. All power was purchased.

The plant serving the office building and the Wallick portion of the hotel contained three cross-drum, water-tube boilers, each with a normal rating of 13,280 lb. of steam an hour. They supplied steam for building and water heating, kitchen, laundry and valet service, house water pumps, boiler feed pumps, air compressor and two steam-driven CO_2 compressors. A third CO_2 compressor is motor driven. In 1928 all power was purchased, and until Feb. 28 of that year the boilers were oil fired. At that time the fuel was changed to gas, with the resulting decrease in cost shown by the curve.

It was felt, however, that costs were still too high. As the hotel used by far the major portion of the service supplied by the plant in the A.I.U. building, arrangements were made for the hotel to take over its operation, operating costs to be shared proportionally. This took place Jan. 1, 1929.

During that year operation of the old Scotch marine boilers in the Deshler plant was discontinued. In addition, the boilers in the A.I.U. plant were changed over to coal firing. This involved installation of two-retort, side-dump, underfeed stokers and coal-handling equipment. The stokers were installed in the rear of the boilers, leaving oil and gas burners intact. This was necessary, as room for the stokers was not available in the front and coal handling would have been more difficult. These changes reduced the combined costs of power services in both buildings from $11,000 to $8,000 a month—a reduction of about 30 per cent.

Up to this time all electric energy used in the hotel and office building had been purchased and its cost included in the combined cost curve. During February, 1930, a generating plant was placed in operation to supply both buildings with electricity. This consisted of one 600-kw. and two 400-kw. vertical unaflow engines direct connected to D.C. generators. Exhaust steam from these units as well as from other steam-driven auxiliaries is used for building heating and heating water for laundry, domestic use and boiler feed. During the winter, exhaust steam is not quite sufficient for these purposes. As will be seen from the curves, operation of the generating plant resulted in a further reduction of cost to a monthly value of 40 per cent below the costs just before the engines were installed.

During 1931 and 1932 the cost of supplying power and steam to the hotel and office building decreased only a small amount. The average monthly kilowatt-hours generated, however, increased from 225,000 to 310,500. This increased use of electric energy at no additional cost was due to more efficient operation and better housekeeping methods introduced by the present engineer, who took charge of the plant during February, 1931.

A few of the things accomplished without increasing the power plant force are:

1. Cleaned out and placed in service over-fire draft gages. This disclosed that the stokers had been operating with 1 in. over-fire draft, which was reduced to 0.1 to 0.2 in.

2. Placed in operation combustion control equipment that had been installed but never operated.

3. Cleaned boilers and reconditioned baffling. Many baffles were found loose, and one row of tiles near the front wall was found missing in each boiler.

4. Condensate found discharging to the sewer at a

number of places was collected in one of the old oil storage tanks, and one of the vacuum pumps was arranged to pump it into a return line going to the feed-water heater.

5. Temperature of the feed water was too low, which was found to be due to air binding in the feed-water heater. Air vents were installed and the feed-water temperature increased to 218 deg.

6. Overhauled all traps.

7. Increased boiler pressure from 120 lb. per sq.in. to 155 lb. per sq.in.

8. Ran tests on coals from four different fields, which resulted in a 10-cent per ton reduction in fuel cost.

9. By increasing the diameter of the pulley on the motor driving the 20-ton CO_2 compressor its capacity was increased so that it would carry all of the refrigerating load in the Wallick portion except air conditioning. This made it possible to shut down the 40-ton engine-driven compressor at night when air conditioning was not required during the summer, whereas it had previously been run continuously.

Through the co-operation of Dr. A. L. Wallick, vice-president of the Deshler-Wallick Hotel, a member of the *Power* staff visited the plant and interviewed the chief engineer, A. H. McGarvey, from whom the cost data in this article were obtained.

SMOKE
AND FLUE DUST

WHILE the present economic situation has necessarily restricted activity in the smoke and pure air field, a number of isolated happenings have occurred which collectively indicate that interest is only apparently dormant. Research at Stevens Institute, Mellon Institute, and installation of dust collecting equipment at the Arrighi Station, Paris (POWER, page 216, April), Ironbridge and Battersea stations in England, and active smoke control in Hudson County, N. J., and in Boston, Mass., are all indications.

Two years of work by Col. Elliott H. Whitlock, Wm. G. Christy and their assistants in Hudson County, N. J., has reduced smoke 80 per cent and been of tremendous aid to health and increased combustion efficiency. The estimates are that some $187,000 in fuel has been saved there annually through Col. Whitlock's research work at Stevens Institute and the engineer-inspector labors of Mr. Christy and his staff. Mr. Christy's men have visited 9,121 smoking plants, each visit a practical lesson in how to obtain complete combustion. These men are licensed engineers who inspect equipment, advising certain repairs or redesign that in many cases effect tremendous saving in fuel. Smoke records show that the work has resulted in these cuts: Railroads cut smoke by 67 per cent, reducing smoke density from 16.03 per cent in 1931 to 5.20 per cent last year (Ringelmann). Stationary plants abated smoke by 45 per cent.

Out at Mellon Institute in Pittsburgh, the sun told its own story in chart form for a full year. H. B. Meller, head of the Air Pollution Investigation there, utilized a scheme which recorded by means of dot density the amount of ultra-violet finding its way through the "smog" to earth. Air pollution was found greatest from October to March, often caused by heavy and improper firing of home furnaces. About half the days, barriers of smoke existed. But in summer, only on one day in eight was the smoke barrier detrimental.

The installation of dust collection equipment at Ironbridge station, near Shrewsbury, England, is said to be the first in the world in which dust collectors are arranged in parallel before the induced-draft fans. This is expected to practically eliminate erosion of fan blades, casings, etc., and to give a dust removal efficiency of 95 per cent.

Ironbridge is a base-load station designed for an ultimate capacity of 200,000-kw., supplied by four 50,000-kw. generators. The first section, which went into service Oct. 13 last, consists of three Stirling boilers, twelve forced and induced draft fans, 36 Davidson dust collectors and a 50,000-kw. generator. Each induced-draft fan has six dust collectors on the suction side, arranged in two rows of three each, with a common dust storage bunker beneath. Many small dust-collecting units instead of one or two large ones provide greater flexibility, for collectors may be shut out to provide maximum dust separation with greatest efficiency at any load. Normally, 8 of the 12 units per boiler are operating.

The collectors are of the familiar dry type with a large horizontal volute casing through which all combustion gases swirl, so that dust particles are thrown outward and downward. No water sprays are used. Fine dust from the battery of collectors, as well as the economizer chambers, is removed by a Hydrovac suction system operated by a water ejector and discharged to two overhead drainage tanks outside the power house, where ash is also brought, for dumping to trucks.

Battersea, 480,000-kw. station of the London Power Co., Ltd., will be the first in England to be completely equipped with a plant to scrub all combustion gases with water sprays to remove the bulk of the acid sulphur compounds, nearly all sulphur dioxide. The first section will include six boilers and two 80,000-kw. turbo-generators. The dust collectors will use hot water sprays at about 160 deg. F., requiring about 17-22 tons of water per ton of coal burned. The station will operate at 650 lb. pressure and 875-900 deg. superheat.

Smoke prevention had an early start—witness this paragraph from the "Transactions of the Society Instituted at London for the Encouragement of Arts, Manufactures and Commerce, with the Premiums offered in the Year 1790, Vol. VIII, London." This reproduction of par. 153, page 305, was discovered recently by Dr. D. S. Jacobus

153. DESTROYING SMOKE. For the beſt account, aſcertained by proper experiments, of a method of deſtroying or burning the ſmoke of fires belonging to Steam Engines, Furnaces employed in calcining or ſmelting Metals, or other large works, in order to prevent annoyance to the neighbourhood; to be produced on or before the firſt Tueſday in January, 1791; the GOLD MEDAL.

BUYING COAL LOOKS EASY

BUT ISN'T!

An interview with G. B. GOULD
President, Fuel Engineering Company of New York

"WHAT is the most important single factor in steam plant economy?"

"There is no single 'most important' factor, but rather three basic factors varying in relative importance from plant to plant. These are: design, operation, coal selection. The design of a steam plant does *not* make its operation either efficient or economical; it merely fixes a *limit* of efficiency and economy beyond which it is impossible to go. Up to this built-in limit of economy, there is a wide range of possible results, depending upon skill in operation and in coal selection."

"Which of these last two is usually the more important?"

"From our fuel-engineering analyses of several hundred plants, it appears that the two are, on the average, about equally important. For example, here is what was found with respect to coal selection in the last 25 plants for which we have been asked to make a fuel-engineering investigation:

"Six of the 25 were using the wrong type of coal to get the best plant operation. Change to the right type of coal allowed better operating efficiency with a lower initial cost of fuel, after allowing for differences in heat value.

"Four others were able to shift to a coal that gave a better heat cost, without affecting efficiency one way or the other. Two plants were buying coal of the general class giving best values at their location, but had not found the particular coals within that class which had the qualities needed for best operation of the plant.

"Seven plants had selected exactly the right kind of coal, but were paying too much in the existing market. Five plants were buying the correct general type of coal at a favorable price, but the quality of the individual coals selected was lower than the market afforded in other coals at the same price. Just one plant of the 25 was buying the right kind of coal at the best possible price and quality.

"The twenty-four cases represent a faliure to make the best adjustment between the individual plant's needs and the coal market.

"Why have so many of these plants failed to reach the most economical solution of a problem which they had been dealing with for years? Who is to blame?"

"Nobody. Few engineers have a good knowledge of fuel-engineering. This specialty is unlike most other branches of engineering because it requires constant and detailed knowledge of markets—fuel markets. Besides that, not one of these 25 plants had any easy way to tell whether the choice of coal was the best possible or not."

"What, in your opinion, is the principal reason why such a large proportion of the plants still have a margin for improvement in economy, in spite of the best efforts of their operating staffs?"

"The main reasons are: a tendency to *under*estimate the task itself, and a functional gap between plant operation and coal buying.

"Many industrial executives so seriously underestimate this task of adjusting coal selection to the plant that they are slow or reluctant to provide their operating men with the extra facilities, outside the plant, that are really needed. And the operating men are reluctant to ask for them for the obvious reason that it would seem to be an admission of personal weakness.

"There are about 6,000 mines producing the coal used in the United States today. There is almost infinite variety in the value and characteristics of the coals produced from these mines. Each plant has to choose from several hundred of that 6,000.

"There can be no single standard of value, because the varying characteristics of coals affect each plant differently. Coal selection is an *individual* job."

"Of course the complexity of the market does account for many misfits in coal selection, yet what you have just said makes me think that, at least, each plant could set up its own standard of values based on the evaporation it gets with different coals. If two coals are offered at the same price, and a certain plant tries some of each coal, and one of them evaporates 10 lb. of water per lb. of coal, and the other only 9½ lb., it ought to be safe to assume that the first coal is more valuable than the second. Isn't that so?"

"There are so many reasons why it is not so, that it will take quite a while to answer that question. In the first place, almost any coal will vary one or two per cent in heat value between shipments. And coal will vary two or three per cent in moisture, depending on the weather to which it has been exposed. These two variables alone are large enough to cause the whole difference between 10 and 9½ lb. evaporation, and yet the two coals over a period of time may average exactly the same in value."

"That might be all right if the plant tried each coal for a few days only. But suppose these were evaporation figures covering a month's evaporation with each coal. Wouldn't the operators strike an average quality for each coal and wouldn't these figures then be a reliable guide to relative values?"

"Whether you use figures that cover a day, a week, or a year, the evaporation per pound of coal, taken by itself, is the most unreliable guide you can select; the shorter the time the more unreliable. What you overlook is that the evaporation is affected not only by the energy value of the fuel itself but also by the efficiency of the plant. It is a scrambled index, and unless you unscramble it, evaporation, taken by itself, tells you nothing reliable about either one."

"But what other index is there?"

"If you are going to measure fuel values, there is a way to do that. If you want to measure the efficiency

of the plant, there is a way to do that. If you want to measure the effect of a coal's characteristics on a plant's efficiency, there is a way to do that. All three are related, but if you try to determine any one of them by a *composite* index (which evaporation is), you learn nothing of value for either coal selection or plant operation."

"Then, do I understand that you advocate abandoning the evaporation records that so many plants keep?"

"No; evaporation records, if accurately observed, are valuable. But they must be properly used. They are very dangerous if they are taken to mean something that they do not mean."

"Can you illustrate this with an example?"

"Here is an actual case. A certain plant tried, among others, two coals, and evaporated with one of them 9.60 lb. of water, and with the other 8.75 lb. From this it was assumed that the first was a much more valuable coal for their purpose."

"What was the matter with that conclusion?"

"In the first place, the operator had no data on the actual qualities of either coal. That seemed unimportant, because what could be more conclusive than the actual

From long experience in the field of fuel engineering, Mr. Gould knows coal—markets, characteristics, applications. His view of the problem is unusual. *Power* here reports an interview in which Mr. Gould answers the questions of an editor who takes the part of a typical reader. The questions are in bold type. The answers, in ordinary type, will interest every engineer who wants to cut steam costs

results? The truth was that these two coals were as nearly alike as two different coals could be, as our own average of a long series of tests of actual deliveries shows. Here are the figures:

	A	B
Volatile	18.5 per cent	21.6 per cent
Ash	6.6	6.5
Moisture	3.2	2.9
Btu. as received	14,195	14,220
Sulphur	1.7	1.4
Fusing point	2,500 deg.	2,750 deg.

"There must have been some characteristic of one of these coals that made it impossible to use it as efficiently as the other?"

"That is exactly the flaw in using evaporation results *alone* as a basis for coal selection. If you drop the matter with that easy assumption you have no chance of perfecting your knowledge of coal selection, of steam plant economy control. In this case, for example, it is a very simple engineering calculation to determine that the plant operated at 69 per cent efficiency with the 'better' coal, but at only 62.6 per cent with the other one. Of course, the plant operator cannot know that, unless he knows the heat value of each coal.

"But the important thing is not this simple interpretation of these facts into terms of efficiency, but the realization that these figures do *not* represent a *conclusion*—that they are merely the *starting point* for a fruitful line of inquiry.

"What *practical* good can you get out of questioning the results?"

"Right here is the fundamental difference between the point of view of the practical man and the scientific attitude. The practical man is too often content to find out only *what* happens; the scientific man wants to know *why* it happened. Knowing that, he can *forecast* a result, or modify conditions to produce any desired result."

"Yes, but what has that to do with coal selection and evaporation figures?"

"Just this. When you use coal to generate steam, you are conducting a process of energy *conversion*. You feed into the furnace a fuel that has a certain *measurable* heat value. You take out of the boiler a certain amount of steam that also has a definite and measurable heat value.

"You have to lose some of the energy in this conversion process. What you don't lose, you keep. But it is *how much* you *lose*, and *why* you lose it, that you really want to know. Evaporation only tells you how much you have kept. It does not tell you how much you started with at the furnace door. You find that out in the laboratory. If you know both of these facts, you can find out by difference how much you have lost. In the case just mentioned, losses were 31 and 27.4 per cent. But you still do not know where or why you lost it.

"It is with these *losses* of heat in the proecss of conversion that *fuel* engineering concerns itself. If you understand and control these losses, the evaporation and efficiency will take care of themselves."

"You mean, if you know enough about these losses, you can relate them to the particular coal qualities that caused them?"

"Yes, but that isn't the whole answer. The evaporation per pound of coal may vary, and frequently does, from day to day, or week to week, by a greater amount than would be accounted for by the widest spread in coal values.

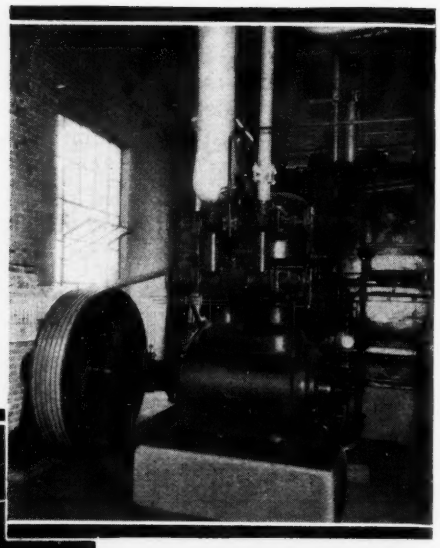
"There are many other things that make these losses vary, and it is just as important to be able to separate those influences that have nothing to do with coal quality, from those that are related to the coal. Inability to separate them makes evaporation figures dangerous and misleading as a measure of relative coal values."

[This interview will be concluded in an early issue. Readers are invited to discuss, briefly, the points raised by Mr. Gould and his questioner.—Editor.]

OIL and GAS

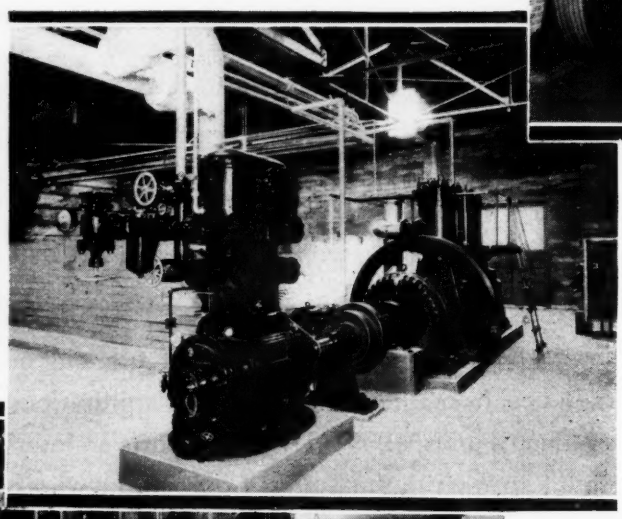
For Ice-Plant Drives

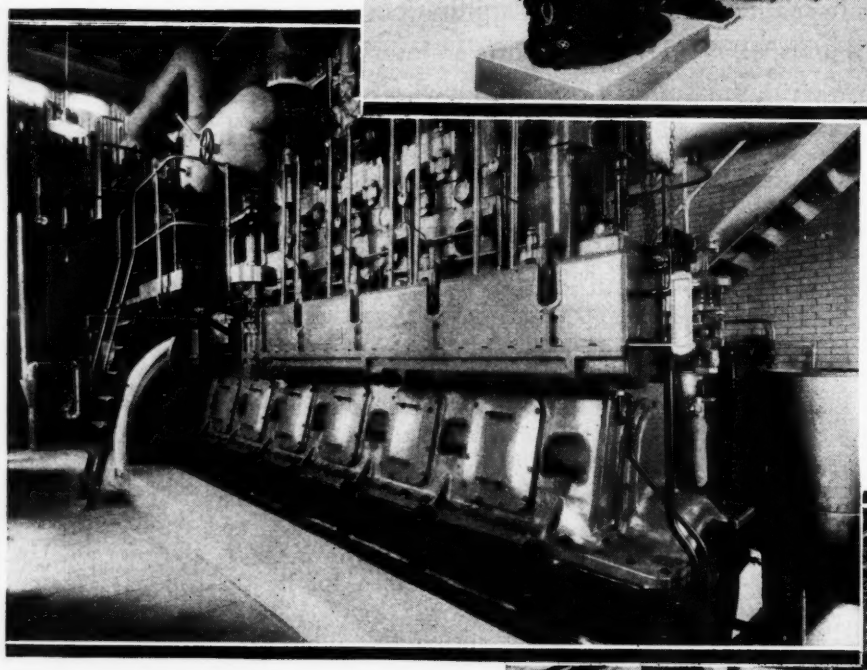
FOUR INSTALLATIONS POINT THE TREND



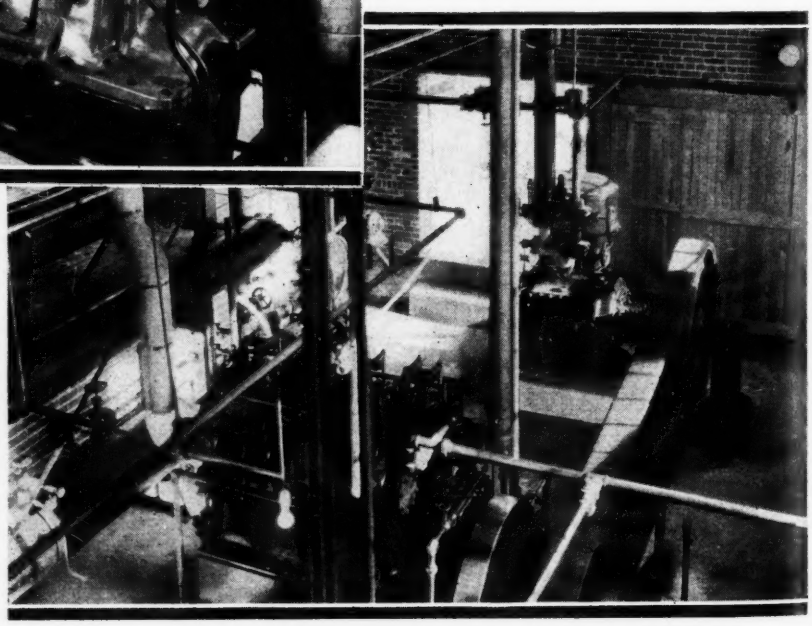
At Dallas, Tex., Superior Ice Co. uses a 10x10 Frick compressor driven by Texrope from a 250-hp. Bruce-MacBeth gas engine. The engine also drives another compressor and a generator for auxiliaries in the 120-ton plant

A dual-suction Frick compressor direct-driven by a Fairbanks-Morse diesel at Grace Bros. Ice & Cold Storage, Santa Rosa, Calif. Two other 10x10 units and auxiliaries are driven by power supplied by the generator shown, supplemented by purchased power at peak periods

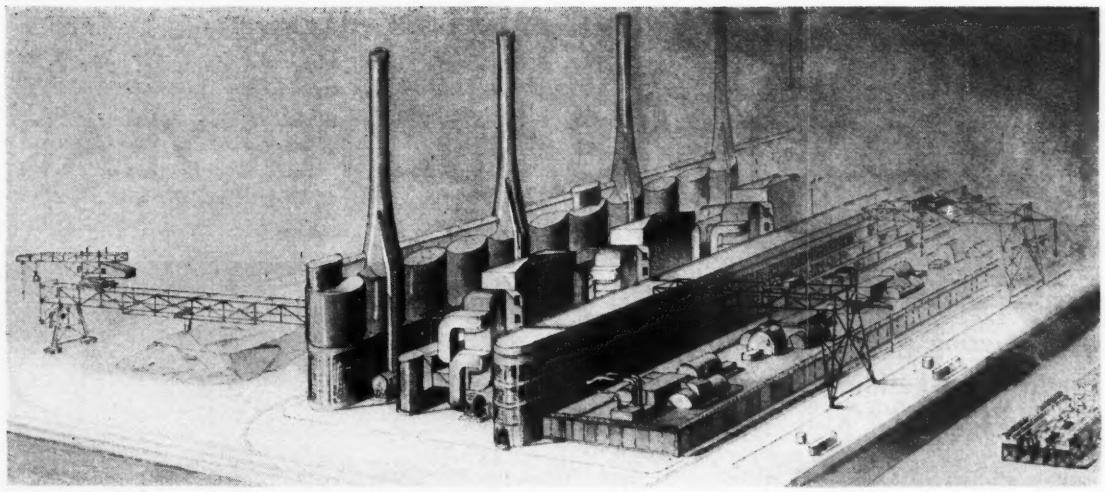




Combined diesel-ammonia compressor which avoids vibration over a sandy-soil foundation at the Long Beach, L. I., plant of Knickerbocker Ice Co. The 4-cyl., 15x18-in. De LaVergne diesel carries two 10x18 ammonia cylinders on the same frame and driven from the same shaft. The unit is rated at 60 tons



Designed for electric drive, the new Stewart Ave. plant of Lunsford-Wilson Ice Co., Atlanta, Ga., was changed to use natural gas. A 4-cyl., 120-hp. Worthington gas engine drives a 9x9 Frick compressor through flat belt and clutch pulley and a 50-kw. alternator by V-belt for auxiliaries and the 5x5 motor-driven compressor



OUTDOOR SUPER-POWER PLANT Designed for New York

AT A MEETING of the American Institute of Electrical Engineers recently held in New York, J. E. Goodale presented preliminary design features of an outdoor generating station proposed for construction in the Astoria section of New York City. This new plant has been designed to contain nine 200,000-kw. turbine generating units to operate with steam at 1,200-lb. pressure and 825 deg. temperature.

In considering the proposed Astoria station, it was felt that present-day reliability of boilers and turbine generators would allow the adoption of a unit design which would assign each boiler to a turbine without interconnection of the steam supply. Considerable saving is expected by the use of outdoor type boilers and turbines, which eliminate all building construction except that required for a service building and a machine shop. The service building will contain the necessary offices and electrical control room.

Each turbine is to be supplied from a single 1,400-lb. pressure boiler fired with the unit system of pulverized fuel and capable of generating 1,700,000 lb. of steam per hour. Air preheaters raise the temperature of the secondary air to approximately 500 deg.

Walkways have been included around each boiler at all levels, with stairways between the levels completely inclosed by corrugated sheet metal. The boilers are not otherwise housed. Inclosed walkways connect the walkway system around the boilers to the service building. The burner platform and a platform at the drum level are also inclosed to facilitate observations of the burners and gage glasses during inclement weather.

To eliminate the possibility of freezing, drains are brought down inside of the boiler casing and run through heated trenches to points of disposal. Safety valves are enclosed by steel lagging. In the event of shutdown during cold weather for periods of a day or less, it is believed that the setting will retain sufficient heat to prevent boiler water temperature from lowering to the freezing point. If a long shutdown were occasioned during extreme cold weather, the boiler could be emptied of water and not refilled until ready for service.

To operate the turbine generators outdoors, and at the same time eliminate the possibility of troubles with lubricating oil, steam drains and water drains, some steel inclosures have been added at certain points. The plans contemplate having the inclosure made up of four removable sections, one of which will completely cover the governing valve, the high-pressure cylinder and bearings and the 400-lb. cylinder. Another section will cover bearings and a part of the cross-over pipe, and a third section will cover bearings between the low-pressure cylinder and generator. The fourth section will cover the outboard generator bearing and exciter. No housing will be provided about the shell of the generator, which will be hydrogen-cooled. All inclosures will be sufficiently large to allow passage between the inclosure wall and the part of the machine inclosed.

Condensers will be located on both sides of the low-pressure cylinder. The circulating water pumps, of the vertical type, will be located over a circulating water pit.

The turbine will be arranged to supply steam to four stages of bleed heating, steam being bled from one point in the high-pressure cylinder, two points in the intermediate cylinder and one point in the low-pressure cylinder. Cross-over connections from the intermediate pressure cylinder to the condenser will permit the low-pressure, double-flow cylinder to be by-passed. Steam will be reheated between the high-pressure and intermediate cylinders to 825 deg. in a flue-gas type reheater. After the high-pressure heater, the feed water is delivered by a secondary feed pump through economizer.

The estimated cost of building this station, exclusive of land and existing coal handling facilities, is $44.21 per kw. for the steam equipment, and $10.22 per kw. for the electrical equipment. The boilers and generators can be housed at an additional cost of $1.63 per kw. The total cost without a building is then $54.43, and with a building, $56.06.

THIS 200-KW. STEAM PLANT

CUT COSTS $8,000 PER YEAR

Improved operation and a change in fuel reduced operating costs 25 per cent in the 36-year-old office building power plant of the St. James Bldg., New York City

METERS and automatic devices are recognized as essential to best power-plant operation. Plants properly equipped with them may be operated under test conditions with high average efficiency and low operating cost. Lack of these refinements, however, is no excuse for not obtaining fairly good operating results, even though the engineer may not be able to prove his figures to the third decimal place. Brains and resourcefulness are good substitutes for many deficiencies in proper power-plant equipment.

In the St. James Building at 26th St. and Broadway, New York City, the power plant is 36 years old. It comprises three 1,500-sq.ft. hand-fired Stirling boilers operating at 110-lb. gage pressure, and one 50-kw. and two 75-kw. steam-engine driven, 120-volt, direct-current generators. There are also five horizontal hydraulic elevator machines with steam-driven pumps. Since management of the building was taken over in January, 1930, by the present agents, Spear & Co., the cost of power-plant operation has been reduced $8,000 a year, $7,000 of it in fuel.

These savings have been obtained by improved operating methods and a change in the quality of coal burned. The chief item of expense in plant improvement was for turbining the boilers. When taking charge of the plant, Charles Kleist, chief engineer since Oct. 9, 1931, first gave attention to the conditions of the boilers, their settings and baffling. While these were being put into condition, a system of weighing coal was set up.

Coal is weighed in the wheelbarrow as it is brought from the bunker to the fire room. Periodically, the weight of a wheelbarrow load is checked with a spring scale. To eliminate as far as possible the error in each load, the barrow is loaded full every time. It is to the fireman's interest to load it this way, for if the barrow is under-loaded it tends to indicate that the coal consumption has increased. Over a period of time, a check-up can be made between the weight of coal delivered to the boilers by wheelbarrow and that put into the bunker. It has been possible to get these two to check closely.

For some time, the fireman's count of wheelbarrow loads was depended on entirely. Recently, Harold Gray, plant electrician, designed and installed an automatic counter. This is a pressure switch placed in the passageway between the fireroom and coal bunker. Each time a load of coal passes over the switch, it closes the circuit to an electrical counter on the engine-room switchboard.

A study of firing methods best suited to the boilers and the quality of coal fired lead to a change in coal. In 1931, No. 1 buckwheat was used and cost an average of $6.89 per ton delivered. Now, a lower grade of anthracite, mixed with bituminous coal is fired. The mixture is 4 to 5 parts of anthracite to 1 of bituminous, costing an average of $5 per ton, and giving a saving of $1.89 per ton.

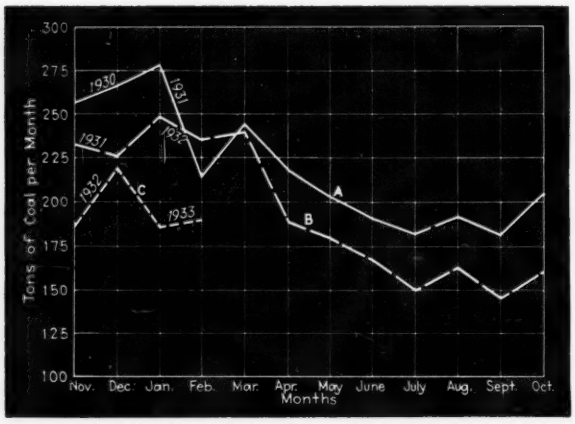


Fig. 1—Curves show monthly coal consumption from November, 1931, to March, 1933

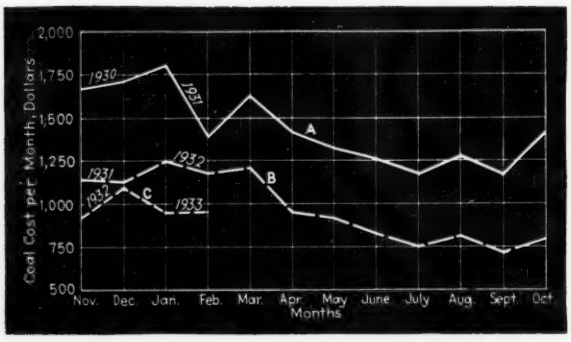


Fig. 2—Curves of monthly coal cost for the period represented in Fig. 1

There is an automatic regulator on the damper in the uptake from the boilers to the stack. So that the fireman may know the position of the damper at all times and judge how to do his firing, a damper-position indicator was constructed and placed in a location easily seen by the fireman. This indicator is connected to the automatic regulator and follows damper position.

A water meter was resurrected from plant stores and installed on the feedwater line so that a fairly accurate record of water going to the boilers is obtained. From this record and the weight of coal fired, the evaporation per pound of coal can be determined with fair accuracy.

In the engine room, the engines were indicated and the valves adjusted to obtain efficient operation.

Pressure water for the elevator is supplied by a large duplex plunger pump. To obtain an indication of the water supplied by this pump, a counter was obtained and

connected to give a record of the strokes. After the counter was installed, an inspection showed pump valve seats to be badly scored. Funds were not available to renew the valve seats, so soft valves were substituted for the hard ones originally used. This change improved pump efficiency so that the number of strokes was reduced from an average of 14,000 to 11,000 per day. This is equivalent to a steam reduction per day for the pump of about 21.5 per cent.

How these improvements reduced coal consumption is indicated by curves *A* and *B*, Fig. 1. Full-line curve *A* shows coal consumption in tons per month for the year from November, 1930, to October, 1931. Improved operation under Mr. Kleist began November, 1931, and the dotted curve *B* gives the coal consumption per month for the following year. In February only did the coal consumption exceed that of a month in the previous year. For the period represented by curve *A*, a total of 2,545 tons of coal were burned, while in the same period of improved operation, curve *B*, 2,286 tons were used, a saving of 259 tons.

Reduction in the total cost tells the real story of what has been attained. This is shown on curves *A* and *B*, Fig. 2. Curve *A* shows the cost of coal by months for the same period represented by curve *A*, Fig. 1, and curve *B* the cost of coal for the following year. Coal cost for the year represented by curve *A* was $17,535 and for the following year $11,430, a saving of $6,105.

Curves *C*, Figs. 1 and 2, show monthly coal consumption and cost through February of the second year of improved operation. It is evident that they will be considerably below those for the preceding year. In December of last year the boilers were turbined and thoroughly cleaned, which is evident by the large decrease in coal consumption in January. Before the boilers were turbined an evaporation of about 8 lb. of water per pound of coal was obtained. Now it is 9 lb.

Steam is now being produced for about 45 cents per 1,000 lb. Included in this cost is fuel, water, boiler-room labor, half of the chief engineer's salary, maintenance and insurance. The plant is 36 years old, therefore the capital charge should have been written off long ago, so that the only other fixed charges are for taxes. Shutting down the plant probably would not save on this item.

This improved operation has also been reflected in the cost of ash handling. Under the old methods of running the plant, an average of 35 cans of ashes per day was obtained, compared to an average of 22 cans per day now, notwithstanding the poorer grade of coal fired.

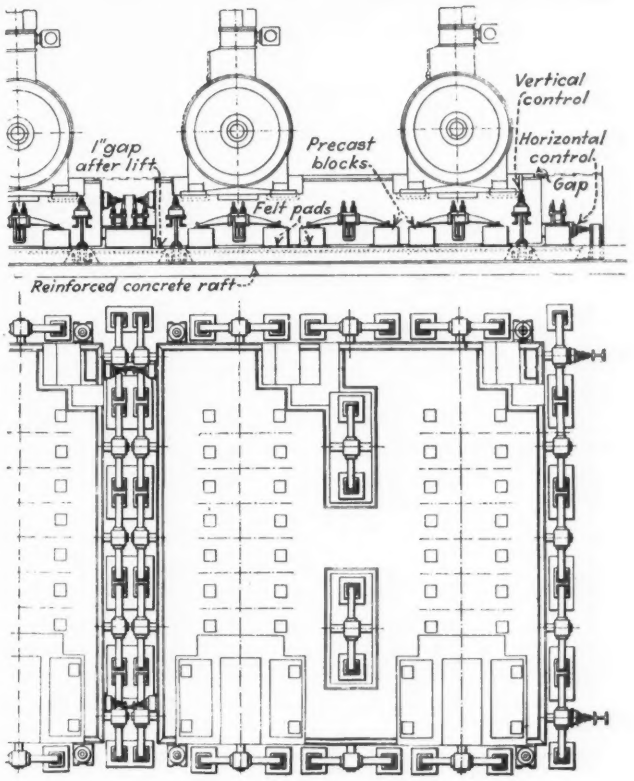
It is estimated that the total saving this year, in plant operation including coal, ash handling, water, maintenance and oil, will be over $8,000 as compared to the year represented by curve *A*, Fig. 2. Of this saving, about $7,000 will be in coal cost. If the comparison is made on a basis of fuel cost in 1930, the 1933 savings will be about $9,000.

Although the plant lacks adequate metering equipment, fairly comprehensive records are maintained of the kilowatt-hours generated, elevator-pump strokes, total water evaporated, temperature of feed-water, evaporation per pound of coal, pounds of coal burned, volume of ashes and outside temperature. These daily records may not be absolutely correct, but they do provide a good basis for comparison, and if there are any radical departures from normal these are immediately detected and their cause determined. From the daily records, monthly and yearly reports are compiled for comparison with those of preceding periods.

LEAF SPRINGS HUSH DIESELS IN LONDON FLAT

SILENCE is golden—particularly in "high-class residential flats close to Hyde Park, London." So the proprietors, Summit Estates, Ltd., called in a consultant to insure that no noise or vibration was transmitted from the diesel power plant to the building. Three vertical, 6-cyl., 500-r.p.m., 120-kw. engine-generator sets comprise the compact plant, to which a fourth unit is being added. The sets are mounted in pairs upon reinforced concrete blocks isolated by a special arrangement of springs and dampers, as in the diagram from *The Power Engineer*, London. The base blocks hang from U-bolts suspended from the centers of the leaf springs, and dampers are provided on all sides, top and bottom.

Somewhat similar methods have been adopted to isolate the exhaust pipe line, which passes from a Cochran exhaust-heat boiler up the side of the building through roof auxiliary horizontal silencers and then across the roof in the form of concrete piping to the main stack. Silencers and roof piping hang in spring-isolated hangers, a series of simple frames from which U-shaped pipe hangers are supported by coil springs. Removable covers lined with mascolite cut down noise from the engines themselves, combustion air is supplied by an inlet fan through suitable ducting to eliminate pulsation, and even the ventilation of the engine room is suitably guarded. Room air, changed 60 times an hour, passes through inlets with special baffled chambers to avoid inlet pulsation.



A CRACK SLEUTH

Magnetic Powder Inspects Turbine Blading

By F. C. JACOBS
Master Mechanic,
West Penn Power Co.

When steam turbines are opened for annual inspection, the blades are inspected for minute flaws and cracks. This difficult job is made easier and more reliable by the magnetic method described

AN UNDETECTED fracture in the spindle blading of a turbine generator may result in a blade failure while the unit is in service. Such blade failures are usually accompanied by blade wrecks. In the larger of the modern turbine-generators, blade wrecks are accompanied by property damage and loss due to outage.

The inspection methods of the operating personnel responsible for the equipment have been challenged by the ever-present possibility that these small defects and fractures may be overlooked. This vexing problem is aggravated to a great extent by the inherent design of the equipment being inspected, for as many as 6,000 blades are used on the single rotating element of the larger turbine-generators. The blades are closely fitted together and are difficult to inspect by ordinary methods.

Earlier inspection methods involved careful examination of the exposed surfaces of the blading by men trained in this work. The only equipment required was a pair of tireless eyes, keen vision and an electric light on an extension cord. From experience, these men knew the more vulnerable locations on the blade surfaces where cracks might develop. These locations were more or less characteristic, depending on blade material, blade contour, and the axial location of the blading on the spindle. The attention of the inspector was to some exent concentrated on these points of greatest vulnerability.

Such visual aids as reading glasses, magnifying lenses, special lights, reflectors and periscopes were gradually brought into service to detect minute fractures beyond the range of the naked eye. However, all of these methods required careful searching of the entire exposed surface to locate a fracture. Obviously, these methods were effective only to the extent of exposing fractures large enough to be within the range of the equipment used for inspection, and were limited by the physical and mental make-up of the inspectors. The eye strain connected with an inspection job of this kind is very great because of the glare of the lights employed and the use of magnifying lenses. This work also produces a severe physical and mental strain because of the investment at stake and the uncertainty that all defects have been found.

To reduce the element of chance and the accompanying physical and mental strain, a search was made for means of making cracks self-indicating.

The much-used whiting and carbon-oil method was tried. In this the blade surface is soaked with carbon oil, wiped clean, and then painted with a whiting solution. After the whiting is dry, the blade is vibrated or jarred. This causes the carbon oil, absorbed by any surface cracks, to stain the whiting. Thus the cracks are self-indicating.

The advantages of such a test method, if reliable, are apparent because the work of inspection is reduced to merely locating the stains, which, being sharply defined, are easy to see and locate.

In actual practice, the whiting method proved to be unsatisfactory because of the difficulty of wiping the blades clean of carbon oil, with the result that the whiting would not adhere to the oil-covered surfaces. In fact, it proved to be practically impossible to secure a clean blade surface under these conditions. Because of this, there was always the possibility that a fracture might be overlooked. Application was also costly and cumbersome.

A method of locating defects in welded sections had been experimented with by our organization. This involves magnetizing the welded section and placing a sheet of paper over the region to be tested. Finely screened iron filings are then sprinkled over the paper. Any cracks or defects in the magnetized section produce magnetic flux leakages at these points. By gently blowing the filings over the paper or vibrating the welded section, the filings conform or stick to the points of greatest flux density, thereby outlining any defects in the welds.

After the failure of the whiting experiment, it was decided to magnetize a spindle and work out some method of applying a magnetic powder over the surface of the blading. This method proved to be surprisingly simple and effective. It was fast, clean, and readily revealed the most minute surface or sub-surface fractures.

Magnetization of the spindle was not a complicated procedure; the simple equipment required is usually available in all power plants. At Springdale a portable arc-welding motor-generator set is used; however, any source of low voltage and fair amperage direct current supply will answer the purpose.

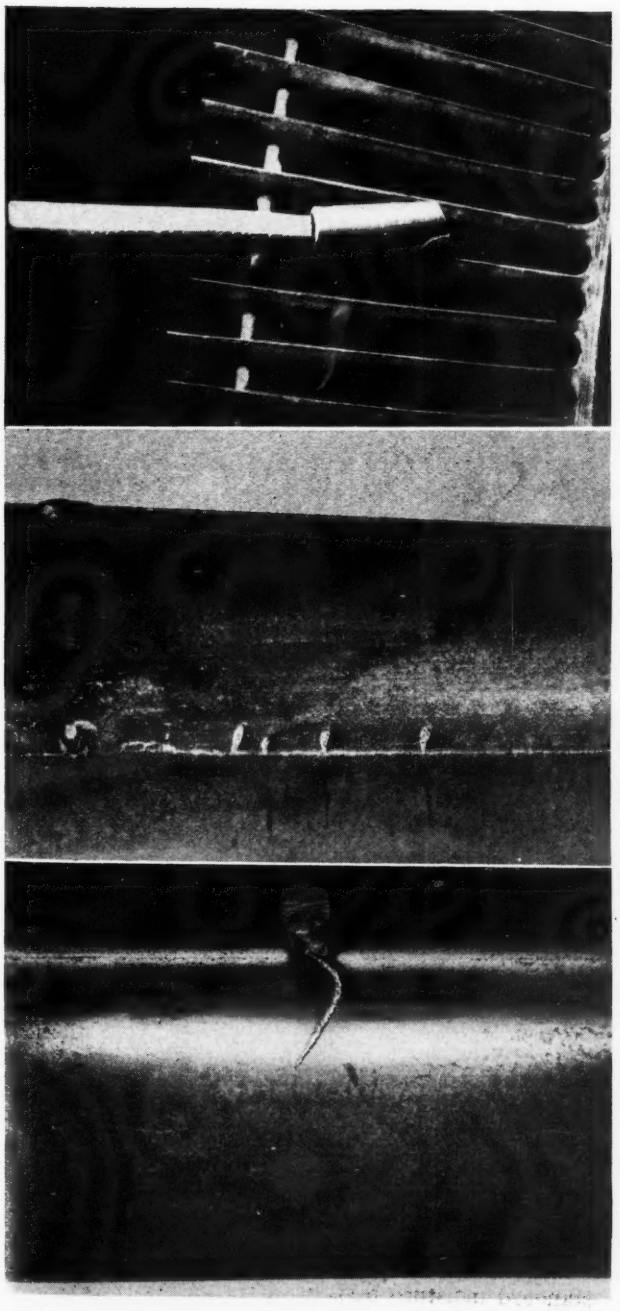
The magnetizing cable is a length of No. 0 insulated flexible copper cable used with the arc-welding set. This is wrapped around the spindle body between two rows of blading. We found that three or four rows of blading on each side of the cable can be magnetized sufficiently for testing, thus six to eight rows of blades can be tested from one setting of the cable.

On a 40,000-kva. turbine spindle, six turns of cable were required and the current rate adjusted to 120 amp. Under these conditions a ten-penny nail will remain fixed in position when the nail head is brought in contact with the end of the blades being tested.

Both wet and dry methods of applying magnetic powders were experimented with. The wet method proved to be messy and it was discovered that the liquid flowing off the blading dislodged the powder adhering over minute cracks, but the larger cracks showed up plainly.

Various kinds and grades of powder were experimented with in developing a dry method. These were all of dark color and offered little contrast with the dark surface of the turbine blades. Because of this there remained the possibility of passing by a small fracture. A tinted magnetic powder was found, sold under the trade name of "Magnaflux," which had the contrast in color desired. Its application has proved extremely simple. The powder is placed in small copper containers or tubes about 1 in. O.D. by 4 in. long, fitted with a fine mesh wire screen over one end. The opposite end is provided with a hole for filling and for inserting a wooden handle long enough to reach in along the edge of the longest blades, as shown in Fig. 1.

Fig. 1 (Top)—Tapping the copper container against magnetized blades causes the powder to sift out through the wire screen on to the blades



Figs. 2-3—The magnetic powder collects around blade cracks, making their detection easy

The tube is tapped lightly against the side of the blading. The tapping causes the powder to sift through the screen in a finely divided shower, which falling down through the openings between the blades settles over the surface of the blade in that immediate vicinity. As the work progresses, the tapping on the blades causes the powder to move over the blade surface and to accumulate at the points of greatest flux density, thereby outlining any cracks which may be present, whether the cracks are visible to the eye or not.

The manner in which the powder arranges itself over a crack is shown in Figs. 2 and 3.

The quantity of powder required for the largest turbine inspection would be less than two pounds or about one quart in volume, most of which can be recovered.

The experiments showed that surface cracks of the order of 0.005 in. deep can be detected; surface cracks covered with silver solder show up readily, and the cracks can be located without eye strain because of the contrasting color of the powder and blading.

Application of the magnetic method of testing turbine blading is, of course, limited to blading materials that can be magnetized, such as the various grades of carbon steel, rustless iron, stainless steel, commercial nickel, etc. Fortunately most of the spindle blading used in the larger spindles is made of these materials.

We have found the method to be inexpensive, in that it requires no expensive special equipment, no special preparation of the surface is necessary, and that it is positive in exposing cracks of the finest type and in the most inaccessible places.

Industrial Plant Cost "Per Kw."

● IT IS CUSTOMARY and proper to state the cost of a central station in dollars per kilowatt of capacity. For the industrial plant, such a figure is entirely meaningless, if obtained by dividing the total cost of the plant by its kilowatt capacity. However, the industrial plant does have its own true cost per kilowatt, obtained by dividing the total kilowatt capacity into the difference between the total cost of the plant and the cost of an equivalent plant to generate process heat only.

With a view to compilation and possible future publication, *Power* will be glad to receive from interested readers actual typical examples of kilowatt investment costs, figured as indicated. These should be accompanied by a statement of kilowatt capacity and maximum continuous steaming capacity of all boilers. Additional information of value would include: number of boilers, maximum process-steam load, total cost of complete plant, cost of power generating equipment and other facts that would help in comparing the data with other plants.

LOW-COST COAL-HANDLING System for Small Plant

By I. W. SUMMERLIN
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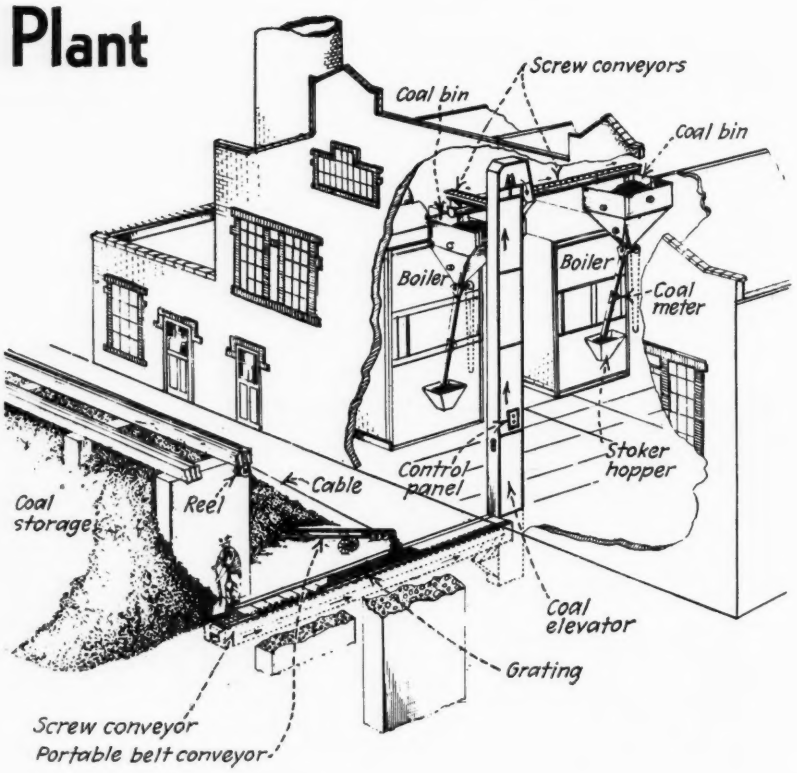
Screw conveyors, bucket elevator, portable conveyor, individual bins and coal meters combine to deliver coal cheaply and effectively in the new coal-handling equipment at the University of North Carolina power plant



WHEN the first estimate for coal-handling equipment was presented to the University of North Carolina, the purchasing agent promptly rejected the whole idea as being too costly. Some months later a revised estimate and layout was presented for his approval. It was as promptly approved as the former proposal was rejected.

The original layout consisted of the conventional inclined conveyor from a coal crusher at the siding near the boiler house to the top of large storage bins supported over the boilers, with spouts for dumping coal into a weigh larry for distribution to stoker hoppers. The principal objections offered to this type of installation for a small plant (located on the campus adjacent to class-room buildings and consisting of five boilers having a total heating surface of approximately 15,000 sq.ft.), are excessive first cost and maintenance; noise from operation; additional labor required for filling bins; coal dust in boiler room; obstructing boiler room space by bin supports; and unsightly appearance of exposed equipment.

As installed, the system has a maximum handling capacity of 23 tons per hour. It consists, as shown in the figure, of a portable belt conveyor for feeding a 14-in. screw conveyor operating in a grating-covered concrete trough with removable cover plates, run underground from coal storage at trestle to bucket elevator inside boiler-room wall. The elevator feeds a 12-in. cross-screw conveyor, which in turn feeds a 12-in. distributing screw conveyor that discharges coal into separate bins suspended over the front of each boiler.

These bins are of approximately 5 tons capacity each and are supported by the front boiler supporting columns and the building structure. Each bin is equipped with a spout running to a stoker hopper. Coal fed to the stokers is weighed and recorded by a vane-type coal meter placed in each spout. Spouts of the swivel-type are used. These allow occasional checking of coal meters by dumping coal onto platform scales.

The various elements of the equipment installed were selected for the following reasons:

1. Screw conveyors and bucket elevator—Low first cost and maintenance; quiet in operation; dust proof.

2. Portable conveyor—Low first cost and maintenance; quiet in operation; ease of handling; cover a wide area.

3. Individual bins at each boiler—Low first cost; adaptability to automatic signals; made of welded steel plate—dust proof.

4. Coal meters—Low first cost; continuous operation requiring no attention; no dust; records weights on a volume basis.

Since the vane-type coal meter records a volumetric measurement the accuracy of reading on a weight basis depends on the uniform density of coal per unit of volume. The weight of any particular grade of coal remains quite uniform, so frequent calibration of the meters is not required. Moisture has little effect on the accuracy of the meters, and moisture variations are due to weather conditions that occur after weights upon which the coal is purchased are taken. When calibrating the meters, moisture samples are taken for correction to a standard moisture basis for day-by-day comparison of weights.

A signal system notifies the operators by bell and lights when the coal bins are nearly full or nearly empty.

In case of failure of the upper limit bin signal, an automatic motor cut-out shuts down the system before the conveyors become jammed with coal. The uppermost bin signal device is placed at a point which will allow the conveying system to empty itself before the uppermost limit switch operates, in order that the starting load may be reduced to a minimum. The lower-limit bin signals are arranged to operate with or without a cut-out switch and are placed to allow ample time for the operators to refill bins before the coal reaches the coal-meter vane in the spout. It is essential that the spout be filled with coal at all times to insure accurate meter readings.

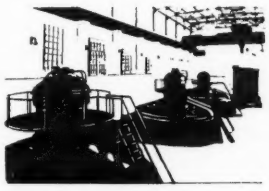
All coal bins are equipped with low-limit signals. The bin adjacent to the elevator has no upper limit signal or limit switch. Coal is fed automatically to this bin first. The conveyor spout to this bin seals up with coal when the bin is filled and coal is conveyed to the next bin without requiring the attention of the operators.

The motors for operating the conveyors and elevators are started from push-button stations and are interlocked to start in proper sequence to prevent jamming in the event the system is shut down before being emptied. The motor driving the portable conveyor is controlled independently. Current is supplied the portable conveyor through a cable paid out from an overhead reel.

No crusher is required. Lumps over $2\frac{1}{2}$-in. are broken on the grille over the underground conveyor. As coal is received at approximately the rate it is consumed, cars are dumped directly over the underground conveyor. Cover plates are removed progressively toward the trestle as coal is fed by gravity to the conveyor. Very little shoveling is required except at intervals when it becomes desirable to use coal that has been stored for some time.

With boilers operating at maximum capacity bins require refilling at 5-hr. intervals. Under normal operating conditions each 9-hr. shift fills the bins once, an operation requiring one-half hour for one man.

FLASHBOARDS REMOVED BY HOIST AND ROPE



By I. W. JONES
Consulting Engineer
Milton, N. H.

AT A hydro-electric plant, flashboards 12 in. high were to be installed on a new dam. It was important, on account of a low yard adjacent to the dam, that the water surface should not rise more than 8 in. over the top of the flashboards before they were removed. Previously, on the old dam, an attempt had been made to install iron pins of such diameter and spacing that they would bend over and release the flashboards automatically when the water reached the prescribed height. The result was that some pins would fail too quickly and others not at all. This was due, in part at least, to the difficulty in obtaining iron pins of a uniform quality, and also to the small margin allowable for inaccuracies. To overcome this difficulty, the writer devised a means by which the flashboards could be raised, any time and at will, without losing them.

Pipes $\frac{3}{4}$ in. in diameter were set in the crest of the dam on 36-in. centers, and $\frac{3}{8}$-in. iron pins were inserted. These pins were not intended to fail and were accordingly made larger than they would be otherwise. The boards, 12 in. wide by 1 in. thick, were all in 16-ft. lengths, excepting those at the ends of the spillway, which were cut to fit the intervening spaces. They were overlapped 12 in. at the joints and were lightly held together by a $\frac{5}{8}$-in. diameter galvanized-iron eyebolt and two large diameter cast-iron washers, thus creating a hinge at each joint. There was also an eyebolt placed in the end boards about 6 in. from the face of the abutments.

The eyebolts were located 4 in. below the top of the boards, allowing the greater proportion of weight to be below the bolts. The eyes of the bolts were all placed on the downstream side. All of the down-stream layer of boards lay fair against the pins, the overlapping being done by the upstream layer. There was a space of 1 in. between the pins and the boards of the upstream layer. Cleats 1-in. thick were nailed to these boards opposite each pin, permitting all of the boards to have a good bearing on the pins.

In each of the end abutments a groove was made for the insertion of the end boards. In one of the abutments a vertical I-beam was anchored and imbedded, and 8 ft. above the crest of the dam a U-bolt was attached to the I-beam. On the opposite abutment a specially designed vertical winch was installed, with a 12-in. diameter sheave, the top of which was 8 ft. above the crest of the dam. The inner face of the sheave was in alignment with the back of the grooves in the abutments. A $\frac{7}{16}$-in. diameter, extra-flexible, steel cable was attached to the U-bolt, then its free end was carried down and through all of the eyebolts in the flashboards up and over the sheave wheel and around the drum of the winch. Therefore, to remove the flashboards it was necessary only to crank the winch, when the flashboards would be raised and suspended above the dam.

This equipment was found to operate successfully, the end boards being first to rise, the others following in succession. The dam, at the winch end, is provided with two 6x6-ft. waste gates equipped with modern screw hoists. These were designed primarily for the discharge of flood water, but they also serve as a means of lowering the pond level for convenience in replacing the flashboards when desired.

This system of flashboards was installed recently at the plant of the Kezar Falls Woolen Company, Kezar Falls, Me. The spillway of the dam, in this case, is 108 ft. long. It would, however, seem practicable in some cases to use this arrangement, with suitable equipment, on dams of greater length and for higher flashboards.

● CORRECTION—The article, "Fuel Injection and Combustion," on page 94 of the February number of *Power*, was signed by Colmar Krause, Berlin Correspondent of *Power*. The name of Herr Günther Leunig should have been added as joint author.

Flexible Performance at High Efficiency Characterizes

Adjustable-Blade, Propeller-Type Pumps

By R. E. B. SHARP

Hydraulic Engineer I. P. Morris Division, Baldwin-Southwark Corp.

Low-head, adjustable-blade propeller-type pumps permit discharge to be varied over a wide range against a constant head or discharge to be held constant during a large change in head, while maintaining a comparatively high efficiency

Fig. 1—Type of propeller pump runner used for making the adjustable-blade tests

ADJUSTING the runner blades of propeller-type pumps improves their characteristics just as it does those of propeller-type turbines. The discharge of a pump can be held constant while the head is varied over a wide range, or the head may be held constant and the discharge varied, either with good efficiency. Performance curves of an 11-in. model adjustable-blade pump in an involute setting, Fig. 3 (developed by the I. P. Morris Division, Baldwin-Southwark Corp.), are shown in Fig. 4. Curves are given for four blade positions, all with the runner operating at 1,000 r.p.m. Fig. 1 is a runner with the blades set at the flattest position, corresponding to curve *A*, Fig. 4.

In Fig. 5, curves are plotted to show the relation between quantity and efficiency for the heads indicated. It is evident from the curve for 8.1-ft. head that it is possible to vary the discharge from 1.5 to 5.75 sec.-ft. by adjusting the runner blades, yet to maintain an efficiency above 60 per cent over the entire range. For a discharge of 3.5 sec.-ft. to maximum, the efficiency is above 70 per cent. Although blade adjustment was limited to the range shown, it is probable that a further adjustment would have raised the discharge to 6 sec.-ft.

The performance of the adjustable-blade pump, operated to give a constant discharge of 5.25 sec.-ft. under heads of 5.7 to 9.6 ft., is compared with that of a fixed-blade pump in Fig. 6. At maximum head, efficiencies of both pumps are the same, about 73 per cent. In the case of the adjustable-blade pump, discharge was maintained constant. With the fixed-blade type, however, discharge under 5.7-ft. head had to be 6.45 sec.-ft. in order to obtain 5.25 sec.-ft. under a 9.6-ft. head, as indicated by Points *X* and *Y* on head curve *D*, Fig. 4. On the basis that any discharge above 5.25 ft. is not required, the equivalent efficiency of the fixed-blade pump under 5.7-ft. head is 56 per cent, as compared to 73 per cent for the adjustable-blade pump. The curves, Fig. 6, show that over practically the entire range of head efficiency of the adjustable-blade pump is materially higher than that of the fixed-blade type. The horsepower for the fixed-blade pump, except at maximum head, is considerably higher than that for the adjustable-blade type.

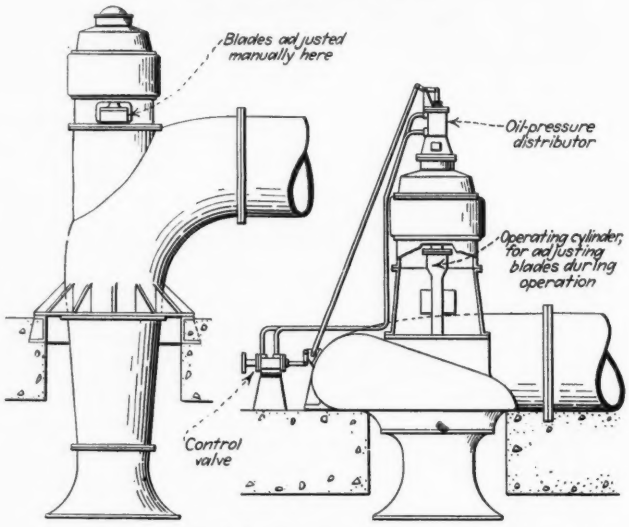


Fig. 2 (Left)—Typical arrangement of an axial-flow pump.

Fig. 3—Propeller-type pump installed in a spiral casing

A disadvantage of propeller-type, high-speed pumps is the power required to operate them at full speed against a closed discharge valve. This advantage is eliminated by adjusting the blades during operation. In Fig. 4 the normal power required with the pump operating under an 8.1-ft. head and discharging 5.8 sec.-ft. was 7 hp. When the discharge valve was closed on this pump and the blade position maintained, power required was 16.5 hp., overloading the motor 100 per cent. With the blades in the flattest position, corresponding to curve *A*, and the discharge valve closed, the power was only 4.8 hp. This shows that it is possible to operate adjustable-blade pumps at full speed against a closed discharge valve without overloading the motor, just as can be done with low-speed centrifugal pumps.

Fig. 2 shows a typical arrangement of an adjustable-blade axial-flow pump arranged for manual adjustment at the coupling between motor and pump shafts. In Fig. 3 the pump has a spiral casing, typical of the Moody pump. The latter permits a greatly reduced over-all height of the pumping unit.

The blade-adjustment mechanism in the runner hub is arranged so that each blade is connected through levers and links to a vertical operating shaft in the pump shaft center. A mechanism has also been developed for moving the blades by turning action of the operating shaft rather than by a reciprocating motion.

It is practicable to design the control mechanism of the runner blades in a similar manner to that employed on Kaplan turbines, permitting blade adjustment during operation. An oil-pressure operating cylinder below the shaft coupling, Fig. 3, accomplishes this. This design involves oil pipes passing through a hole in the motor shaft to the operating cylinder. Oil pipes would be led from a distribution head, located above the motor, to a control valve. This control valve may be operated manually, or automatically, by either suction or discharge level.

Applications where adjustable-blade pumps may be used advantageously are in sewage plants, where it is often desirable to maintain constant level in the suction basin with varying discharge. For these requirements, automatic-blade control may be utilized by having the water level actuate the control valve. The blades may be adjusted manually, but more accurate regulation of water level can be secured by automatic control.

For irrigation it is frequently desired to maintain a constant discharge into the canals when head on the pump varies. Local conditions will determine whether automatic or manual blade adjustment will best meet the requirements. In drainage work the head often increases increased discharge, requiring adjustment in the runner-blade angle and pump capacity. As drainage pumps are generally in operation only a small part of the time probably manual adjustment will meet requirements for this service.

Circulating-water applications in power plants is a fourth service for which adjustable-blade propeller pumps are suited. Under these conditions the amount of water required varies with temperature. These requirements can be met either by manual or automatic control of the runner blades.

Fig. 4—Characteristic curves of a propeller-type pump with the runner blades set at four different angles

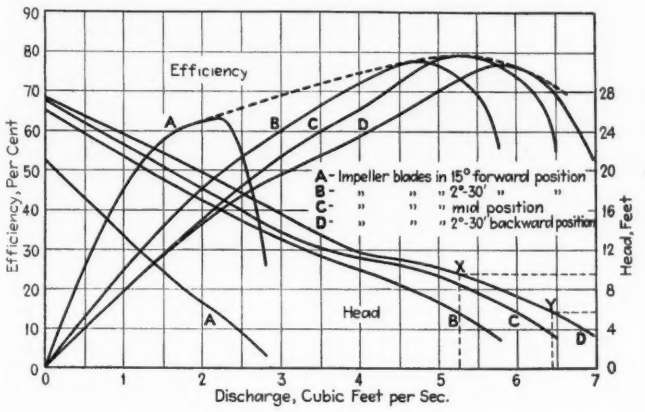

Efficiency
Head
A- Impeller blades in 15° forward position
B- " " " 2°-30' " "
C- " " " mid position
D- " " " 2°-30' backward position
Efficiency, Per Cent
Head, Feet
Discharge, Cubic Feet per Sec.

Fig. 5—Discharge-efficiency curves for an adjustable-blade pump at five different heads

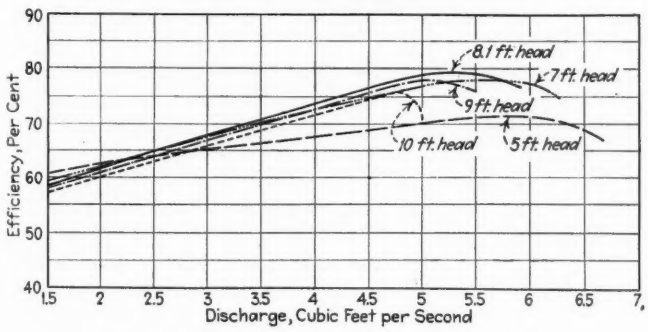
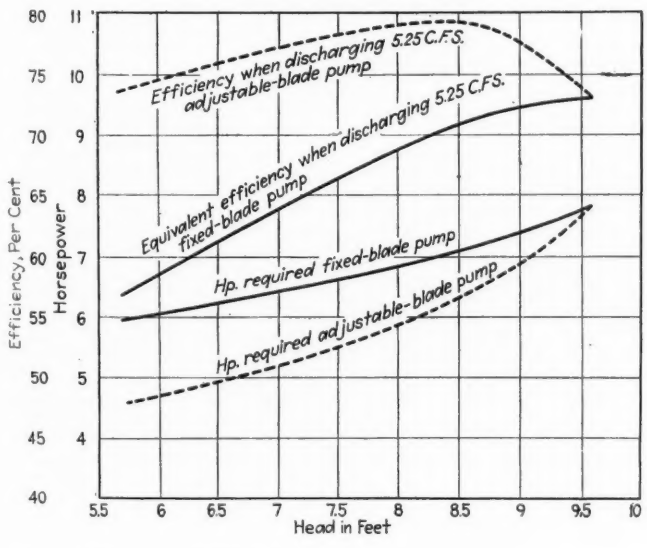


Fig. 6—Head-efficiency and head-power curves with constant discharge


Efficiency when discharging 5.25 C.F.S. adjustable-blade pump
Equivalent efficiency when discharging 5.25 C.F.S. fixed-blade pump
Hp. required fixed-blade pump
Hp. required adjustable-blade pump
Efficiency, Per Cent
Horsepower
Head in Feet

LONG-DISTANCE HEAT FEELER

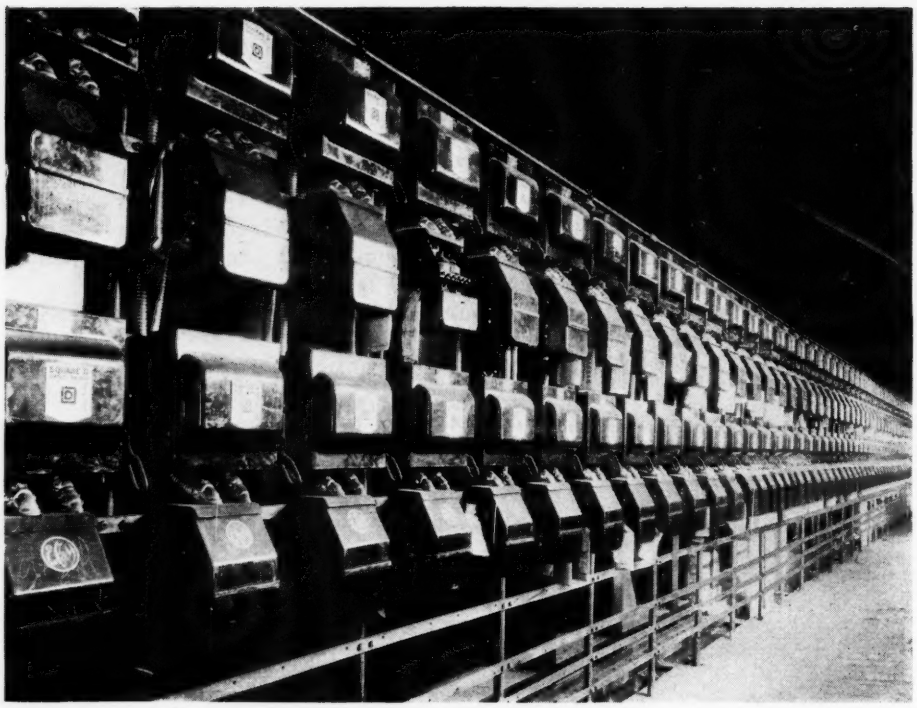
● HEAT, even though invisible, reveals its presence through infra-red rays. A new infra-red "fog-eye" for ships, developed by Commander Paul H. Macneil, enables a navigator to detect icebergs, beacons and other vessels which cannot be seen because of darkness or fog. When demonstrated in New York recently, the device indicated power plant chimneys a half dozen miles away and tugs two or three miles away through a "pea-soup" fog, all by means of heat radiated from their stacks. It renders battleship smoke screens useless. It can detect the heat of a man's face at a mile, the heat of a horse's body at two miles. It will "feel out" an airplane flying above the clouds and indicate which of several persons in a group is feverish. In Congress, it might indicate sources of hot air; in a power plant, heat of flue or exhaust gases.

FUEL GAS DATA CORRECTION

● IN PREPARING the curve showing fuel costs per kilowatt-hour for gas engines, published in the April number of *Power*, page 194, at lower left, the draftsman inadvertently omitted the decimal point before the index figures relating to the cost of gas in cents per kilowatt-hour. Instead of running from 1 to 11 cents per kw.-hr., these should be from 0.1 to 1.1. In other words, a fuel cost figure derived from the published chart should be divided by 10.

By MARIN PHILLIPS
Tarentum, Pa.

Three types of construction are here suggested that insure safety, reliability, and low operating costs in electrical installations



Controls for more than 500 motors are located in this group

Substantial Electrical Installations Reduce Maintenance Costs

MUCH can be done to prevent trouble by correctly planning electrical-equipment installations. Intelligent lay-out and installation by competent engineers is low in cost when considered with the resulting increased reliability in operation and the saving in maintenance expense. All wiring should be run inclosed and the equipment should be arranged so that it is easily inspected and maintained.

Fig. 1 shows the type of construction that has proved satisfactory in one plant to support busbars and standard enclosed safety switches. This has measured up to all that was expected of it through the reduction of accidents and delays, and has also facilitated clearing of the few troubles that have occurred.

The panel boards are built in two separate sections, one the frame for mounting the switches and the other an enclosure for the busbars that distributes the power from the main feeder to the safety switches. The support for the distribution box and switches is constructed of T or angle iron, mounted on a channel-iron base. No. 14 gauge iron is mounted on the front of the framework, and the safety switches mounted on it. Panel box size is governed by the dimensions and number of safety switches to be mounted. Fig. 1 shows the dimensions for a panel box containing nine 60-amp., 500-volt safety switches.

On top of the panel-board framework is a distribution box constructed of No. 14 gauge sheet iron, and containing the busbars mounted on slate bases. These slate supports have slots sawed in them to hold the busbars securely in place. The busbars are made long enough to come within about 6 in. of each end of the distribution box.

Main power feeders enter the distribution box in conduit, and terminal lugs are soldered to them for connection to the busbars. The top row of safety switches is connected to the distribution box by short nipples, while short lengths of conduit extend from the others. These conduits contain the line wiring for the switches. These conductors are connected to the busbars in the distribution box by terminal lugs. Lock washers are placed under the heads of the bolts to prevent them from working loose. Holes are drilled and tapped into the busbars, for making the connections, before they are permanently mounted.

On the safety switches the top terminals are used for the line connections, so that the fuses are dead when the switch is open. Consequently, fuses can be changed without danger of coming is contact with live parts. This is necessary to protect operators and maintenance men whose duty it is to change fuses. Safety switches are constructed so that their doors cannot be opened until the switches are opened. They should also be provided with a lock so that only authorized workmen may open the door for inspections.

The distribution box is mounted with its front flush with that of the safety switches, as in the figure, and is kept far enough away from the wall to allow the conduit lines to pass back of it. To obtain a compact appearance, only sufficient room is left between the bottom of

the distribution box and the top row of switches to open and close their covers conveniently.

It is advisable in most cases to make the panel box a little larger than is needed to provide for future motor installations. This is easily taken care of by leaving space at the bottom of the panel for another row of switches when needed.

A panel box of the type shown in Fig. 1 has the advantages of providing independent circuits for the motors; it is easily accessible, which makes it safe when changing fuses, repairs are easily made; there are no splices such as are made in junction boxes, thereby insuring a more reliable installation; the construction guards against short circuits, as all circuits are well separated and insulated and there is no danger of making contact with the busbars when working on the switches; extensions and changes can be easily made; the switches, being centralized, are readily protected from water, chemical fumes and explosive hazards by inclosing them in a separate room.

At first thought this distribution center may appear expensive to build. When all factors are taken into consideration, however, it will be found not to cost any more than an installation where extra junction boxes are provided and the several switches are in different locations.

It is also an advantage to have all motor-control equipment conveniently and substantially mounted and to facilitate inspection and maintenance. Fig. 2 shows a method of mounting starting boxes and switches for a single unit, where grouping of more than one control is not warranted. The framework is built of $\frac{1}{4}$x1$\frac{1}{2}$-in. angle iron. A good substantial installation is made with a framework of this kind, and it is easy to change a switch or starter at any time. Another advantage is that the switch and starter can be mounted as a unit in the shop and then set up easily where wanted. A spare unit can also be quickly set up to meet an emergency such as the failure of a starter or switch or the installation of a larger size motor.

In places where several motors are located near each other, it will be advantageous to control them from a central point. In this case several switches and starters are mounted on one rack similar to Fig. 2, with the power distribution box mounted on top of the rack. The framework is built of angle iron, the size of which depends on the number of starters to be grouped and their size. Such a starter rack can often be placed on a raised platform where it is dry and out of the way and at the same time in full view of the motors to be controlled.

Slip-ring-motor control consists of a resistance-bank controller and an oil switch or magnetic contactor. Fig. 3 is an arrangement for the control of a slip-ring motor and may be mounted as a unit on an angle-iron framework. It has the same advantages as the one in Fig. 2 for a squirrel-cage motor. There should be an interlock between the controller and starting switch on slip-ring motors to prevent connecting the motor to the line when the controller handle is away from the off position.

When the installation is completed and the motors are in operation, they should be tested with a curve-drawing wattmeter. Then the test records can be preserved for future use. Some motors may be found overloaded, while others will be underloaded. These should be rearranged so that they will be as nearly fully loaded as possible, in order to obtain a high power factor. This will improve operation by maintaining better voltage regulation at the motors, and the generating efficiency will be increased because of the lower currents for a given power output. Tests on motors can be conveniently made when several safety switches are mounted in a distribution center as shown in Fig. 1, as it is not necessary to move current and potential transformers, meters and other equipment to widely separated locations for each motor tested.

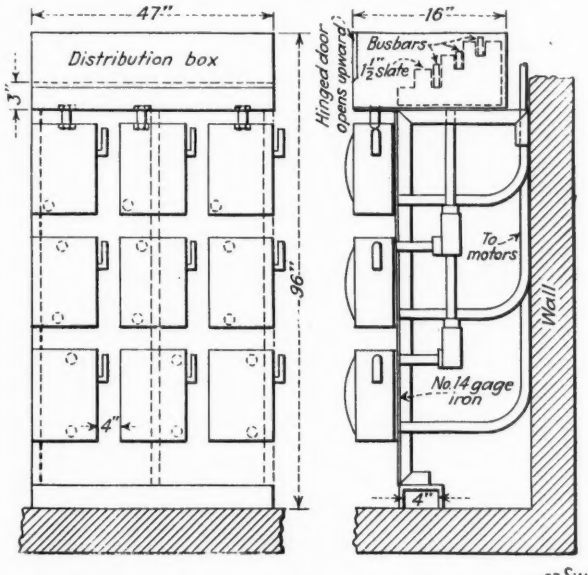


Fig. 1 — Construction for mounting load-center busbars and safety switches

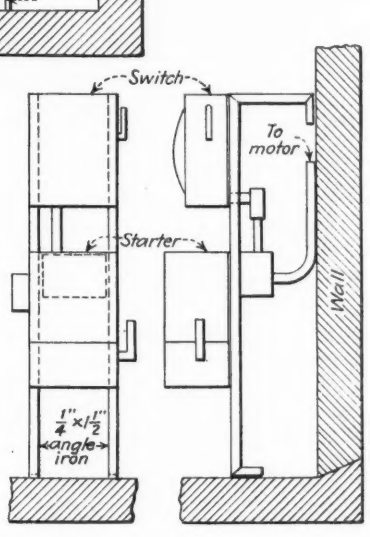


Fig. 2—Method of mounting switch and starter for squirrel-cage motor

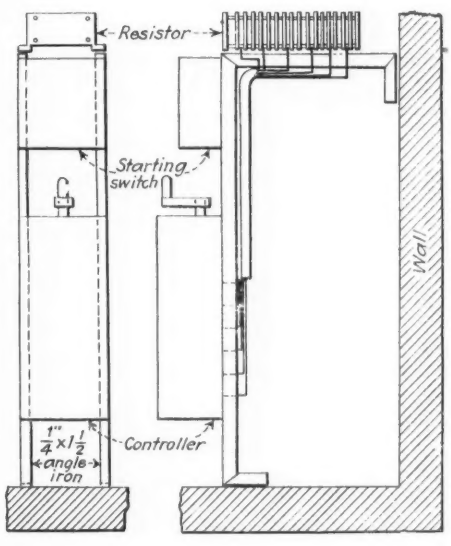


Fig. 3 (Right)—Arrangement of control equipment for slip-ring motor

Dual Drive Improves STEAM-PLANT ECONOMY

By E. C. DIEFFENBACH
Industrial Engineering Department
General Electric Company

DUAL drive normally consists of a turbine and a motor, both directly connected or geared to a common load and each having sufficient capacity to drive the load. Either the turbine or the motor may be used as the major source of power, or the load can be divided between them in any proportion desired to maintain heat balance between load and process.

While the dual drive may be only a small part of an industrial power plant, the interchangeable use of steam and electric power can be utilized to secure economical results in improved heat balance, dependability and a wider speed range than that obtainable with motor or turbine alone.

The turbine employed with dual drive is usually a non-condensing unit operating with or without back pressure. Speed or back-pressure governing are commonly used when supplying exhaust steam to a process. Some dual-drive units require that the turbine run with little or no load, ready to carry load immediately should the electric drive fail.

The electric motor is generally either a synchronous, squirrel-cage or wound-rotor type. The synchronous motor is a precise-speed machine and is better suited for large applications. Where it normally drives the load with the turbine spinning ready for instant changeover, the synchronous motor can be used to advantage. It can also be used to supply leading kilovolt-amperes to the line, thus improving the power factor and voltage regulation, and increasing system capacity. A squirrel-cage motor is the simplest of the three types, but in its standard form has only one speed which is near synchronous. The wound-rotor induction motor permits some speed variation.

If dual drive operates in a favorable location, free from such harmful agents as vapors, dripping water, corrosive fumes, oils, dusts and high ambient temperatures, standard open-type motors are usually satisfactory. Where conditions are less favorable, enclosed, fan-cooled motors or enclosed motors ventilated by air from an external source are available. Where drives operate in hazardous locations, as in oil refineries or chemical plants, collector-ring protection is desirable.

Synchronous and wound-rotor motors so protected are the equal in safety to standard, open, squirrel-cage motors. If greater protection is desired, squirrel-cage motors are available that bears the Underwriters' Laboratories label and are suitable for hazardous locations (Class 1 Group D as specified in the National Electric Code). This construction is not available in the larger ratings. Explosion-proof motors have a wide-flange construction and have enclosing cases of extra strength to withstand the pressure of an internal explosion. Wide flanges permit the projected flame to cool before it reaches outside the motor. Possibility of high ambient temperatures when operating near steam pipes or other heated bodies must be considered, as special inorganic insulations may be necessary.

A number of dual-drive applications are shown on the opposite page. In one installation, direct current is supplied to a paper-mill motor by a dual-drive generator set. Dual drive was selected mainly to supply low-pressure steam to dryers and insure dependability during temporary disturbance of the electrical power supply.

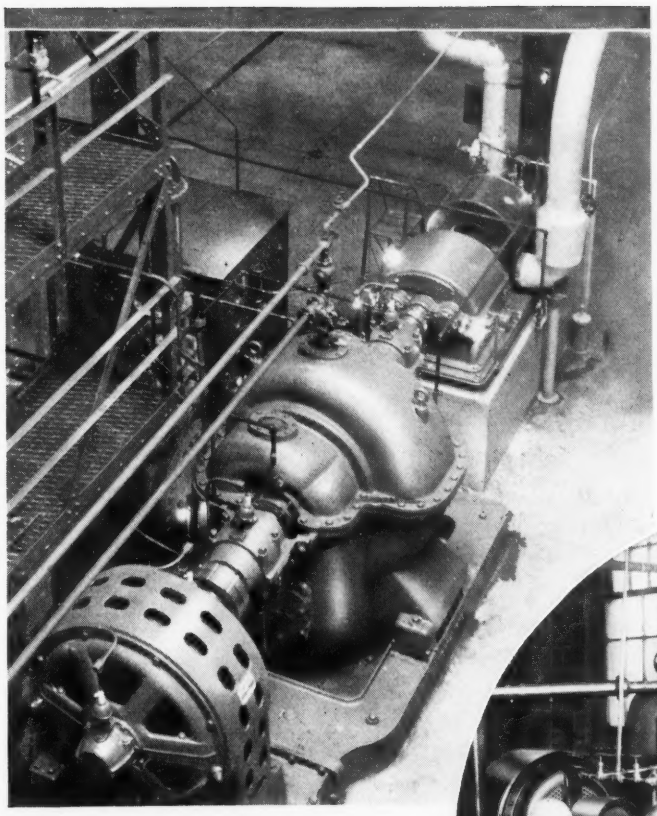
In another installation a synchronous motor and a turbine drive a generator that supplies direct-current to the paper machine motor. Normally only the steam necessary for the dryers pass through the turbine and is governed by back pressure on the dryers. The synchronous motor supplies the remainder of the power required by the generator. When dryer demands are heavy, surplus power produced by the turbine drives the synchronous motor as a generator to supply current to the line. During a major power disturbance the turbine takes all the load and maintains normal speed. Excess exhaust steam is released by relief valves.

Central-stations and industrial power plants sometimes employ dual drive for station auxiliaries, such as feedwater and circulating pumps, where outage would be serious. Modern water-tube boilers have small reserve water capacity, and some condenser-water circulating operations are vital to station operation. Dual drive insures high reliability by a quick change from electric to steam drive or vice versa.

Steam generating stations without a connection to a public-utility or industrial power plant requires power for excitation and for electrically driven auxiliaries when starting cold. Dual drive can be used in such plants, the turbine driving the starting generator or exciter until the main power supply is available; the motor then takes the load.

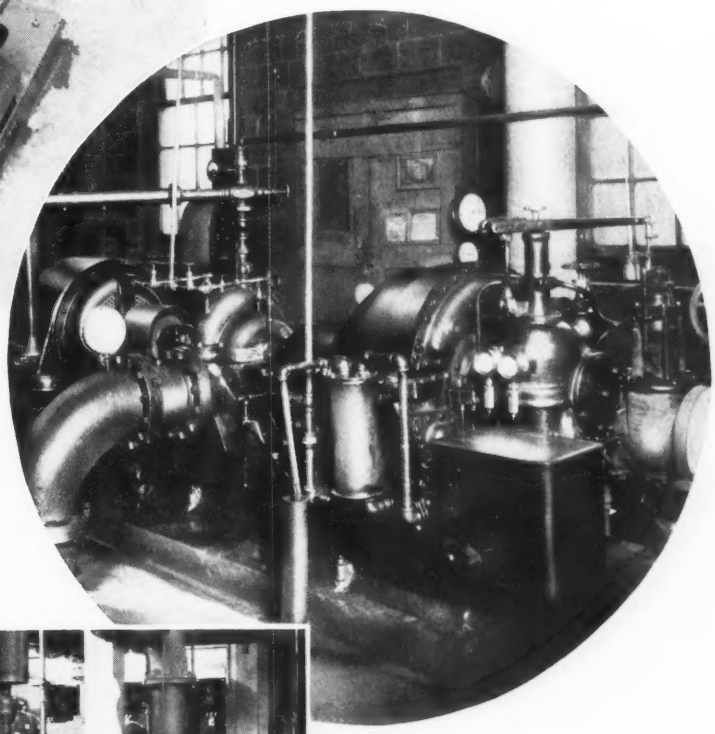
In most cases it is desirable to control the plant's heat balance and this is materially aided by dual drive. When used to supplement exhaust steam from other steam-driven auxiliaries or from stage extraction, dual drive provides an excellent means for supplying additional heating steam when required.

One central station uses a dual drive for the jet condenser removal pump. A synchronous motor and steam turbine are connected to two pumps. The arrangement is such that either turbine or motor drives one or both pumps and provides exhaust steam for heat balance. If desired, the synchronous motor can be used to improve power factor. The two operations, heat balancing and power-factor control, are under operator supervision.

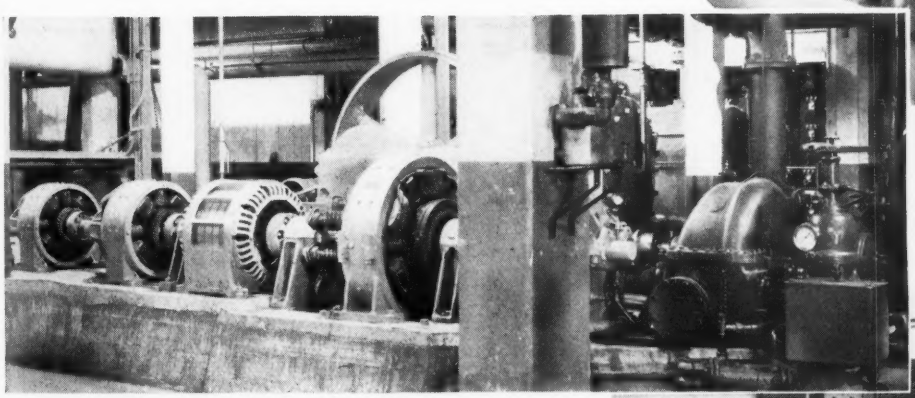


• ONE of four condenser circulating-water centrifugal pumps, driven by a geared steam turbine and a direct-connected induction motor

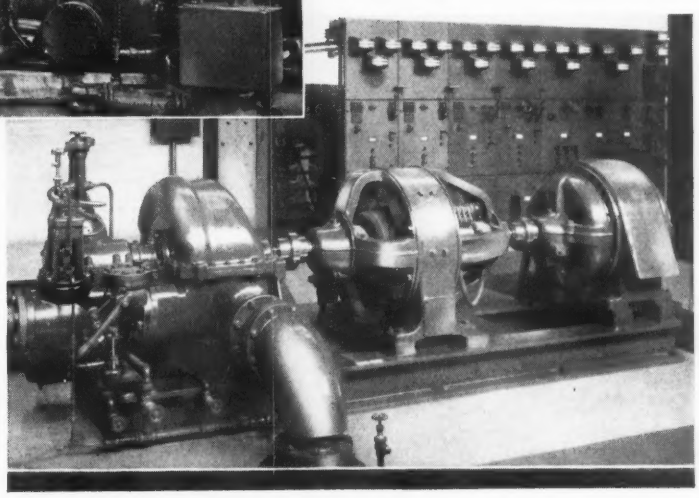
TEAMED HORSEPOWER



• A 250-HP. steam turbine and an induction motor drive a centrifugal pump in a chemical plant

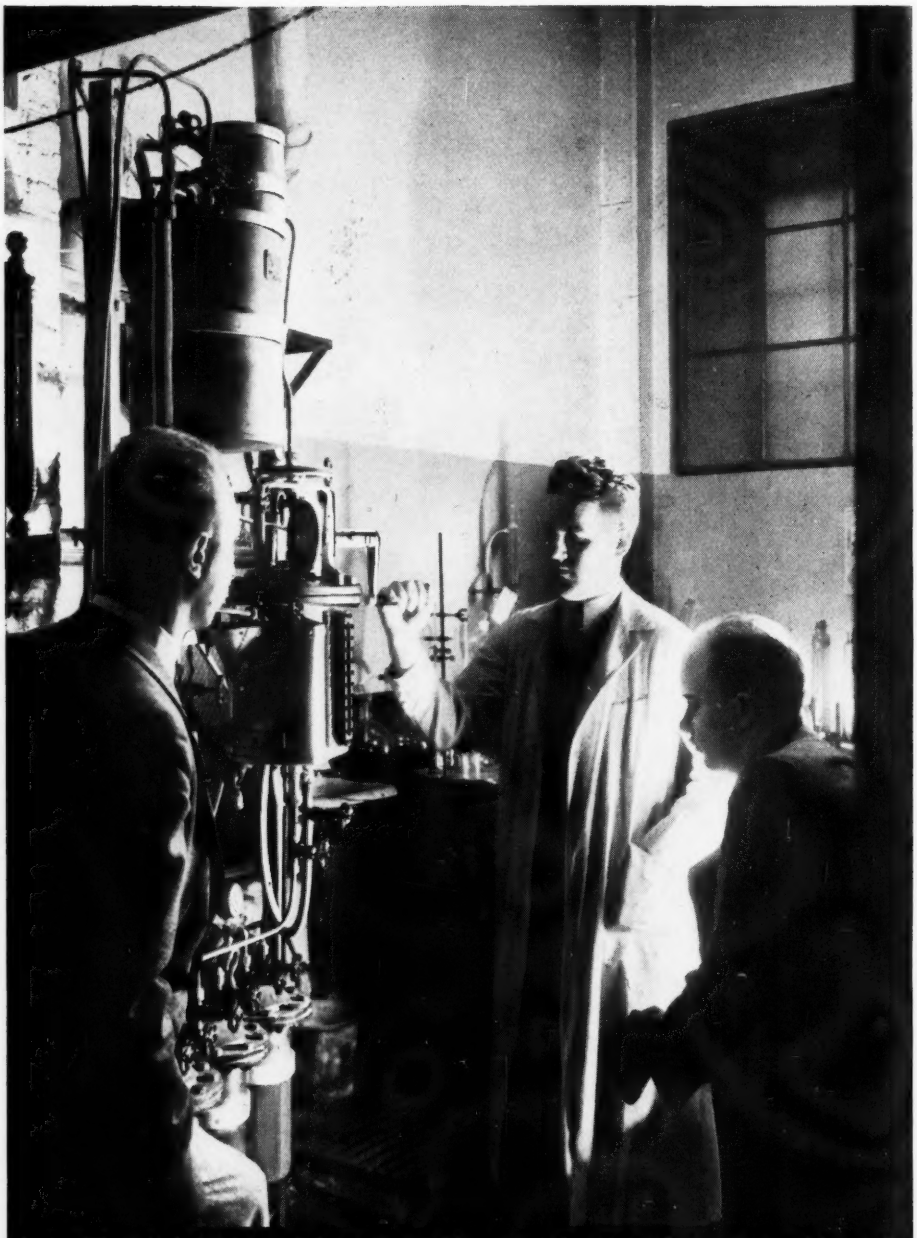


• GEARED steam-turbine synchronous-motor generator set which supplies power to a sectional paper machine drive



• STEAM turbine and induction motor drive 75-kw. exciter in a paper-mill plant

Another Proof



Tide Water's laboratory Edeleanu machine used for RE-*refining* competitive oils. These tests are witnessed and certified by the Electrical Testing Laboratories, N. Y. C.

Data from this RE-*refining Test*

Tests	*Submitted Sample (100%)*	*Purified Oil (89.4%)*	*Unstable Impurities (10.6%)*
Gravity	25.9	28.2	10.2
Viscosity at 100° F.	439	377	5067
Viscosity at 210° F.	59.5	59	104
Percentage Carbon Residue	0.13	0.05	1.63
Oxidation Number	94	3	140

# of Tycol's Lubricating Economy

...Power Plant Operator CONVINCED

10.6% of sludge-forming material removed from this competitive oil *by Edeleanu* RE-*refining*

MORE and more users of turbine and Diesel oils are saying "prove it." We accept every challenge. We RE-*refine* a sample of their turbine or Diesel oil before their eyes, by Tide Water's Edeleanu Process. No matter how well it was refined originally, we remove impurities that cannot be extracted by conventional refining.

A typical example

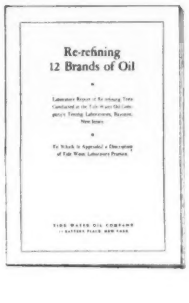
This power plant operator was using an oil rated high in quality. Yet Tide Water removed 10.6% of unstable extract by the Edeleanu Process. The extract was a heavy asphalt-like material with a low gravity. Its viscosity changed greatly with temperature. It was unstable, oxidizing readily, and had a high carbon residue.

Witness the change effected by RE-*refining*. Every characteristic improved greatly (see table). What more convincing proof could be asked of the superior quality of Tide Water turbine and Diesel oils, inasmuch as they are all refined by the Edeleanu Process. Conventional refining cannot produce oils of such high lubricating quality.

Service confirms tests

All of the laboratory-indicated superiorities of Tycol Turbine and Diesel Oils are verified by convincing service records obtained by some of the leading producers of power. It's the combination of 100% paraffine base and Tide Water's exclusive process which causes these lubricants to excel. No chemical action is involved, merely solution of all unstable hydrocarbons. Better demulsibility and more efficient lubrication result.

Tide Water's Edeleanu Process and the methods used in testing competitive oils are described in detail in our laboratory report "RE-*refining* 12 Brands of Oil." A copy is yours for the asking. Tide Water Oil Sales Corporation, 17 Battery Place, New York, N. Y.



INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER

LUBRICANTS *and* FUELS

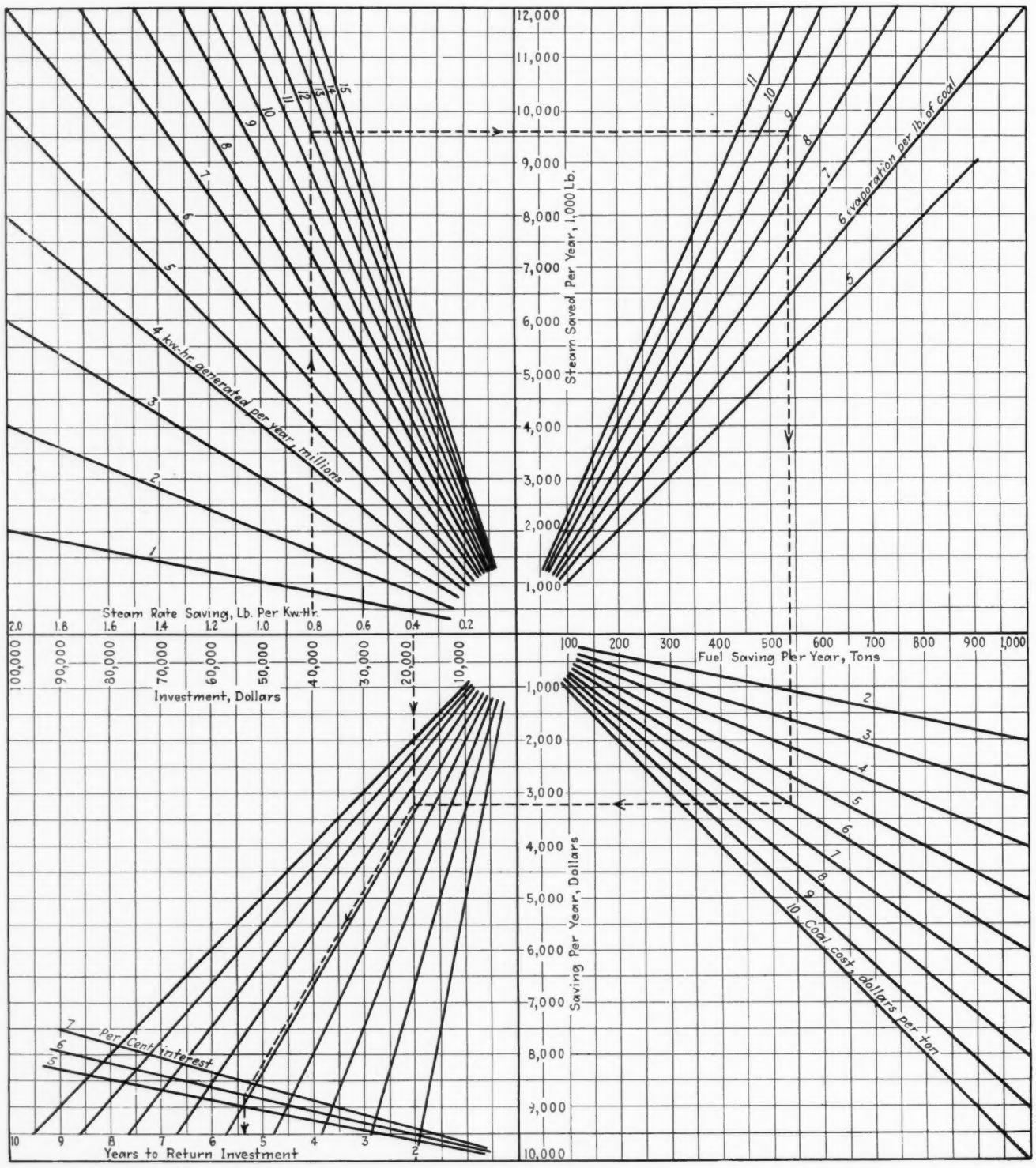
Compressor Oils	Hydraulic Turbine Oils
Cutting Oils	Steam Cylinder Oils
Textile Oils	Ball and Roller Bearing Greases
Transformer Oils	High Pressure Greases
Gear Greases	Roll Neck Greases
Fuel Oils	

STEAM SAVINGS VS. INVESTMENT

THE cost of replacing or improving an uneconomical turbine or engine is justified when the savings will return the investment within a certain time. The time required for a given decrease in steam rate to return the capital cost can be quickly determined from the chart.

Example: Reblading a turbine at a cost of $20,000 will decrease its steam rate 0.8 lb. per kw.-hr. Coal used costs $6 a ton and evaporates 9 lb. of water per pound. Interest rate, 6 per cent. The unit generates 12,000,000 kw.-hr. a year. Starting in the upper left-hand square and going around the chart clockwise, it is found that the new blading reduces steam consumption by 9,600,000 lb. per year, saving 540 tons of coal, or $3,200. This saving at 6 per cent interest will return the $20,000 investment in 5.4 years.

Multiplying any scale by 10 will require a similar change on each of the succeeding horizontal or vertical scales, except the scale of years. By this means all practical problems can be solved.



Courtesy of Brown Boveri Review

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Current Research in Power and Allied Fields

● FOR TWO REASONS, engineers are interested in research in fields related to power and steam generation. First, power equipment, whose improvement spells decreased power-service costs, depends for that improvement upon basic information derived from research. Second, better operating methods are found through research.

● *POWER*, TWO YEARS AGO, published a table of some 600 research projects then in progress. First of its kind anywhere, it elicited so many requests for similar surveys at regular intervals that this second tabulation has been compiled, listing work completed during 1931, 1932 and 1933, together with work still in progress.

● MORE THAN 700 ITEMS are included, taken from replies from more than 130 universities and colleges, various manufacturers, engineering societies, the U. S. Bureau of Standards, Bureau of Mines and other Governmental agencies. Foreign research is reported from various sources, including engineering societies, particularly the V.D.I. (which published recently a survey of German research) and from the Canadian government bureaus.

● PROJECTS HAVE BEEN GROUPED in broad classifications for convenience. Compared with the previous survey, there appears to be increased research activity on boiler corrosion, heat transfer, pumps and welding, and less work on condensers, feedwater, fuels and steam prime movers.

● IT IS A TRIBUTE to the broadmindedness of power research engineers that such a tabulation is possible, for without their aid this table could not be. But in thus serving all who design and operate power plants and equipment, they have served themselves as well.

BOILERS

Circulation in water-tube boilers—At Mason Lab. of Yale U. Directed by Norbert Steckler. Sponsored by W. J. Wohlenberg. Completed June, 1932. Thesis.

Flow of water and steam in boiler tubes—At Riley Stoker Corp.; Sponsored by Riley Stoker Corp. Completed. Resulted in shading certain tubes by baffles to protect them from excessive heat.

Direction and rate of circulation in Navy boilers—At U. S. Naval Eng. Exp. Station, Annapolis. Directed by J. B. Lincoln. Sponsored by Bureau of Eng., Navy Dept. In progress.

Design and tests of high-pressure boilers—At Purdue U. Directed by A. A. Potter, H. L. Solberg, G. A. Hawkins. Sponsored by Purdue Eng. Expt. Sta., and Mfgrs. In progress. Reports published in A.S.M.E. "Journal" and misc. publications. A study of the utilization of steam at extra high pressure.

Theoretical research on circulation in boilers—At Mason Lab. of Yale U. Directed by W. J. Wohlenberg. Sponsored by W. J. Wohlenberg. In progress.

Circulation of water in steam boilers—At Heat Engine Laboratory, Munich. Directed by A. Loschge and R. Quack. Sponsored by the Munich Technical College. In progress.

Velocity of rise of steam bubbles in boiler tubes—At Machinery Lab. Danzig. Directed by E. Schmidt, P. Behringer. Sponsored by the Danzig Technical College. Completed 1932.

Circulation of water in boiler models—At Machinery Lab., Danzig. Directed by E. Schmidt and W. Schurig. Sponsored by the Danzig Technical College. Completed 1932.

Circulation in water-tube boilers during firing up—At Copenhagen, Denmark. Directed by P. Ronne, boiler inspector. Sponsored by City of Copenhagen. Completed. To be published.

Foaming and priming of boiler water—At Dept. of Chemistry and Ohio State U. Eng. Exp. Station. Directed by C. W. Foulk. Sponsored by Boiler Feedwater Studies Committee, A.S.M.E. and Ohio State U. Eng. Exp. Station. In progress. Published results, Eng. Exp. Station "News" Ohio State U., April, 1932, to be published in "Industrial & Eng. Chem." Different kinds of solid matter exhibit greatly differing degrees of foam stabilizing power. The few materials that have been studied lose this foam stabilizing power rapidly at the temperatures of water boiling at absolute pressures of 100 to 150 lb. per sq.in.

Entrainment in evaporators—At U. of Michigan. Directed by W. L. Badger. Sponsored by the U. of Michigan. In progress. Date of completion June, 1933. Apparatus complete and working.

Entrainment of solids in steam carry-over—At U. of Illinois. Directed by F. G. Straub. Sponsored by Utilities Research Comm. Inc. Started in 1933.

Water-wall heat absorption in a stoker-fired furnace—At Mason Lab. of Yale U. Directed by Harwood F. Mullikin. Sponsored by Superheater Co. Completed June, 1931; Essay for degree of Master of Science in Mech. Eng.

Rate of heat transfer in a cast-iron boiler—At Mass. Inst. of Tech. Directed by J. Holt. Sponsored by M.I.T. Mech. Eng. Dept. Completed; not published.

Economic distribution of heating surfaces in a steam-generating unit—At Johns Hopkins U. Directed by A. G. Christie. Sponsored by Johns Hopkins U. Completed; not published.

Discharge capacity, opening and closing characteristics of various safety valves—At H. C. Orsted Power Station. Sponsored by the Copenhagen Lighting Department. Completed; not published.

Stresses in boiler tubes subjected to high rates of heat absorption—At U. of Nebraska. Directed by W. L. DeBoufre. Sponsored by U. of Nebraska, Combustion Eng. Co. Completed, 1932. A.S.M.E. "Trans.," 1932

Strains in boilers and seamless tubes—At Materials Lab., Aachen. Directed by F. Rotscher, Hennes. Sponsored by Aachen Technical College. In progress.

Tube bending in water-tube boilers, causes and consequences—At City of Copenhagen, Denmark. Directed by P. Ronne. Sponsored by City of Copenhagen. Completed. Danish Eng. Soc. serial report B No. 8.

Physical properties of A.S.T.M. grades A and B seamless boiler tubes at 850 deg. F.—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by Detroit Edison Co. Completed, 1932. Grade B steels superior to Grade A.

Alloy steels as material for boiler drums—At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by W. C. Stewart. Sponsored by Bureau of Eng., Navy Dept. In progress.

Physical properties and behavior of materials for heavy boiler-drum plates—At U. of Michigan. Directed by Prof. A. E. White and R. Schneidewind. Sponsored by Detroit Edison Co. In progress. Best results are believed to be obtained by use of killed steel.

Strains in boiler drums with and without expanded water tubes—At Lab. for Mech. Technology, Munich. Directed by L. Föppel and H. Schröter. Sponsored by Munich Technical College. Completed; not published.

Durability of rolled joints—At Materials Testing Bureau, Stuttgart. Directed by E. Siebel. Sponsored by the Stuttgart Technical College. In progress.

Durability of rolled joints—At Materials Testing Bureau, Darmstadt. Di-

POWER'S RESEARCH TABLE

rected by A. Thum and Ruttmann. Sponsored by Darmstadt Technical College. Tentative completion by end of 1932.

Application of exhaust-heat reclaimer to two-stroke diesel engine—At U. of Wisconsin. In progress. Project S 14.

COMBUSTION

Effect of preheated air on fuel-bed characteristics—At U. S. Bureau of Mines, Pittsburgh Exp. Sta. Directed by P. Nicholls. Sponsored by U. S. Bureau of Mines. In progress.

Mechanism of combustion of solid carbon—At Mass. Inst. of Tech. Directed by C. M. Tu and H. C. Hottel. Sponsored by M.I.T. Fuel Eng. Lab. Thesis; not published. Up to 800 deg. C., specific rate of combustion depends on rate of chemical reaction at carbon surface. From 800-1200 deg. C., rate is determined by resistance to both diffusion and chemical action. Above 1200 deg. C., diffusion controls combustion rate.

Combustion process in boiler fireboxes—At Heat Engine Lab., Munich. Directed by A. Loschge and W. Meier. Sponsored by Munich Technical College. In progress.

Effect of moisture on combustion performance of coal—At Ohio State U. Eng. Exp. Sta. Sponsored by Ohio State U. Eng. Exp. Sta. In progress. Not published. Plans are being made to study the effect of moisture on the ignition, caking and combustion characteristics, and on the efficiency of operation of coal burning.

Combustion in the fire-box of inclined tubular boiler—At Machinery Lab., Breslau. Directed by H. Baer and R. Loewenstein. Sponsored by Breslau Technical College. Part 1 completed; to be concluded.

Comparative combustion tests with low-grade and small-sized fuels, hand and stoker fired on special grates—At Canada Dept. of Mines, Fuel Research Lab. Directed by Mines Branch, Fuels & Fuel Testing Division. Report in Press.

Properties of flames — At Bureau of Standards. Sponsored by Bureau of Standards. In progress.

Luminous flame combustion—At U. of Wisconsin. Directed by O. L. Kowalke, R. J. Altpeter and G. G. Dormer. Sponsored by U. of Wisconsin and Wisconsin Gas Assoc. Completed June, 1932. U. of Wisconsin master's thesis.

True temperature and total radiation from luminous gas flames—At Mass. Inst. of Tech. Directed by H. C. Hottel and F. P. Broughton. Sponsored by M.I.T. Fuel Eng. Lab. I and E.C., "Anal. Ed." 4 (1932) 166.

Mechanism of combustion of solid fuels—At Carnegie Inst. of Tech. In progress.

Smokeless combustion of coals—At U. of Washington. Completed, 1932.

Combustibility and quality of coke—At Foundry Institute, Aachen. Directed by E. Piwowarski. Sponsored by Aachen Technical College. In progress.

Air flow in stoker plenum chambers and its effect on combustion—At American Engineering Co. Lab. Sponsored by American Engineering Co. Not published. Great improvements in air distribution are possible.

Air flow through various types of grate surfaces—At Riley Stoker Corp. Sponsored by Riley Stoker Corp. In progress. Furnishes data for grate and tuyere design.

Effect of agglutinating power of coal upon resistance to passage of air through thin fuel beds—At U. of Michigan. Directed by Prof. A. E. White, Prof. E. S. Pettyjohn and A. W. Fleer. Sponsored by U. of Michigan. In progress; date of completion, 1934. To be published Distribution of air over large stokers is materially influenced by the agglutinating power of coal used.

Study of travelling-grate-stoker surface to determine design of grates to resist furnace temperatures — At Riley Stoker Corp. Sponsored by Riley Stoker Corp. In progress. Has so far resulted in improving design of grate surface.

Combustion of Iowa coals in various stokers—At Iowa State Col. of Agr. In progress.

Automatic stokers and economy with N. & W. Ry. coals—Sponsored by the N. & W. Ry. In progress; work started in 1929.

Tests of bituminous gravity-feed stoker furnaces—At U. of Utah.

Study of stoker reduction drive and power consumed — At Riley Stoker Corp. Sponsored by the Riley Stoker Corp. Completed. Resulted in new design of more efficient reduction drive.

Stoker drive under excessive loading—At Riley Stoker Corp. Sponsored by Riley Stoker Corp. Completed. Resulted in adoption of most economical materials for work required.

Mechanism of combustion of pulverized coal—At Mason Lab., Yale U. Directed by W. J. Wohlenberg. Sponsored by W. J. Wohlenberg. In progress.

Combustion of pulverized coal—At Battelle Memorial Inst. Directed by R. A. Sherman. Sponsored by Battelle Memorial Inst. Proc. Third International Conference on Bituminous Coal, Carnegie Inst. of Technology, 1931. Continued to include typical coals of U. S.

Removal of ash as molten slag from powdered coal furnaces—At U. S. Bureau of Mines, Pittsburgh Exp. Sta. Directed by P. Nicholls. Sponsored by U. S. Bureau of Mines and A.S.M.E. "Fuels in Science and Practice," Vol. XI (1932).

Relation between combustibility and grain size of coal dust — At Experimental Section, Berg-Akademie Freiberg. Directed by K. Kegel, Arnold. Sponsored by Berg-Akademie Freiberg. Completed, 1932.

Sampling of pulverized coal in coal-air streams—At National Cash Register Co. and Ohio State U. Eng. Exp. Sta. Directed by A. H. Dierker and D. J. Demorest. Sponsored by National Cash Register Co. and Ohio State U. Eng. Exp. Station. In progress (temporarily suspended). Not published.

Radiation from pulverized coal flames—At Battelle Memorial Inst. Directed by R. A. Sherman. Sponsored by Battelle Memorial Inst. In progress.

Comparative combustion tests with pulverized B.C., Alta., and Ontario lignite fuels—At Canada Dept. of Mines, Fuel Research Lab. Sponsored by Mines Branch, Fuels & Fuel Testing Div., in co-operation with B.C. Government and coal operators, Alta. Government and coal operators, Ont. Dept. of Mines and Ont. Research Fndtn. Private reports, Mines Branch Memorandum Series No. 56, Bulletin now in progress. Fuels found to be amenable to use in pulverized form.

Flameless combustion, in which an attempt is made to burn oil with high combustion efficiencies and without flame—At Oregon State Agr. College. Directed by F. G. Baender and Don Lindsay. Sponsored by Oregon State College Eng. School. Not completed, not in progress. Easy to burn oil at very high efficiencies without flame. Method lends itself readily to a mixture of oil and air that is practically and almost theoretically perfect. Has commercial possibilities in domestic and industrial applications.

Influence of combustion chamber size on rate of oil burning in a heating boiler — At Mass. Inst. of Tech. Directed by C. L. Svenson and A. L. Hesselschwerdt. Sponsored by M.I.T. Mech. Eng. Dept. Thesis. Not published.

Combustion chamber design for cast-iron, oil-fired boiler—At Mass. Inst. of Tech. Directed by J. Holt. Sponsored by M.I.T. Mech. Eng. Dept. In progress.

Application of oil burners to various types of boilers, furnaces and heating systems—At Yale U. Directed by Prof. L. E. Seeley. Sponsored by Am. Oil Burner Assoc. Publication in the "Journal of A.S.H.V.E."

Gaseous combustion in closed vessels—At U. of Michigan. Directed by Prof. Geo. G. Brown and J. Wright. Sponsored by U. of Michigan. In progress.

Fundamental processes of gaseous combustion—At Peoples Gas Light & Coke Co. Directed by R. B. Harper. Sponsored by Utilities Research Comm. Inc. In progress.

Radiation from luminous and non-luminous natural gas flames—At Battelle Memorial Inst. Directed by R. A. Sherman. Sponsored by Battelle Memorial Inst. Completed 1932. Presented Pittsburgh Meeting Iron and Steel Division, A.S.M.E., Feb. 17, 1933.

Kinetics and mechanism of gaseous explosions—At U. S. Bureau of Mines, Pittsburgh Exp. Sta. Directed by B. Lewis. Sponsored by U. S. Bureau of Mines and Carnegie Inst. of Tech. "Jour. Amer. Chem. Soc.," Vol. 53 (1931), Vol. 54 (1932).

Effect of mixing coals on ash-fusion temperature of mixture—At Carnegie Inst. of Tech. In progress.

POWER'S RESEARCH TABLE

Remmey oxy-acetylene test furnace for coal-ash fusion point determination—At Virginia Polytechnic Inst. Directed by F. H. Fish, F. M. Taylor and J. L. Porter. Sponsored by Virginia Eng. Exp. Sta. Bulletin No. 12 of Virginia Eng. Exp. Station. Shows feasibility of using this simplified method.

Flue-gas analysis based on specific gravity of the gases — At Combustion Lab., Aachen. Directed by H. Bonin. Sponsored by Aachen Technical College. In progress.

Characteristics of pipettes and reagents for the analysis of flue gases—At Dept. of Mech. Eng., Ohio State U. Directed by Paul Bucher and H. M. Faust. Sponsored by Dept. of Mech. Eng. and Ohio State U. Eng. Exp. Station. In progress. Not published. The speed and the absorption capacity of different solutions and types of pipettes are being determined in connection with this work.

Temperature gradient in stacks—At Laboratory for Technological Physics, Munich. Directed by O. Knoblauch and W. Mull. Sponsored by Munich Technical College. Completed.

Coal dust explosions and fires, their nature, cause and prevention—At Lignite Research Institute, Berg-Akademie Freiberg. Directed by R. V. Walther, M. Steinbrecher. Sponsored by Berg-Akademie Freiberg. Part I, Halle, 1931. In progress.

Spontaneous combustion of stored coal, a laboratory study—At Purdue U. Directed by H. C. Peffer and P. A. Tetrault. Sponsored by Purdue Eng. Exp. Sta. In progress.

Distribution of the various losses in the boiler heat balance item ordinarily reported as, "Heat loss due to unconsumed hydrogen and hydrocarbons, radiation and unaccounted for" — At Dept. of Mech. Eng., Ohio State U. Directed by Paul Bucher and H. M. Faust. Sponsored by Dept. of Mech. Eng. and Ohio State U. Eng. Exp. Station. In progress. Not published.

Carbon dioxide-hydrogen ratio in products of combustion of certain fuels —At Columbia U. Directed by J. J. Morgan. Sponsored by Columbia U. M.S. Thesis about ready for publication.

Equipment for measuring convection and radiation losses from steam-generating units—At Detroit Edison Co. Sponsored by Detroit Edison Co. Completed.

CORROSION

Apparatus for inspection of austenitic corrosion-resistant steel—At Bureau of Standards. Sponsored by Bureau of Standards. Completed. To be published in B. S. "Jour. Research."

Modified apparatus for impingement corrosion determinations — At I. C. I. Metals, Ltd. Directed by H. W. Brownsdon and L. C. Bannister. Sponsored by I. C. Metals, Ltd. Completed. Published in Inst. of Metals, Advance copy No. 608, 1932.

Accelerated corrosion tests — Sponsored by A.S.T.M. Comm. A-5. In progress. A.S.T.M. Comm. A-5 report 1932. Various methods of accelerated corrosion tests, with reference to their application to metallic coatings studied.

Prevention of corrosion in refrigerating systems—At Hall Laboratories, Inc. In progress.

Prevention of corrosion in steam heating systems—At Hall Laboratories, Inc. Published in "Heating, Piping and Air Conditioning." Vol. 3, pages 943-59, 1041-9 (1931).

Prevention of corrosion in air-conditioning systems—At Hall Laboratories, Inc.

Preventing scale and corrosion in steam boilers by electrical methods—At U. of Nebraska. Directed by Prof. W. L. De Baufre. Sponsored by U. of Nebraska, Combustion Eng. Corp. Completed. "Combustion," May, 1932.

Investigation of various paints, etc., as protective coats for feed-water tanks and hotwells—At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by Lieut. R. R. Gurley, J. G. O'Neill. Sponsored by Bureau of Eng., Navy Dept. In progress. Preliminary report published in "American Soc. of Naval Eng. Proc." for August, 1932. So far the solution appears to be in the synthetic resin group of paints.

Protective coatings for water, gas and soil pipes—At National Tube Co. Directed by F. N. Speller. Sponsored by National District Heating Assoc.

Protective value of electroplated metal coatings on steel—At Bureau of Standards. Sponsored by Amer. Electroplater Soc., A.S.T.M., Bureau of Standards. In progress. Coatings included are nickel, copper, chromium, cadmium and zinc.

Protecting iron and steel against corrosion—At Columbia U. Directed by C. G. Fink. Sponsored by Columbia U. In progress. Investigation of zinc-cadmium coatings.

Protection of iron and steel by chromium plate—At Columbia U. Directed by C. G. Fink. Sponsored by Columbia U. Theory of the electrodeposition of chromium.

Protection of steel against corrosion—At Columbia U. Directed by C. G. Fink. Sponsored by Columbia U. Published in Trans. Am. Electro-chem. Soc., Vol. 58, 457-62 (1930); "Metal Industry" (N. Y.), Vol. 29, 116-7 (1931). A film of lead-thallium on iron and steel makes iron and steel highly resistant to corrosion. Lead-thallium alloys are more resistant to corrosion than either lead or thallium alone.

Corrosion tests of electroplated coatings—Field tests, five locations. Sponsored by A.S.T.M. Comm. A-5. In progress. Report by A.S.T.M. Comm. A-5, 1932.

Atmospheric corrosion tests of metallic-coated products—Field tests at several locations. Sponsored by A.S.T.M. Comm. A-5. In progress. Published in A.S.T.M. Proc. Vol. 31, p. 181, 1931. An important purpose of the tests is to correlate results of service with various laboratory tests.

Corrosion resistance of stainless steels of different heat-treatments—At Brooklyn Edison Co. Sponsored by Brooklyn Edison Co. In progress. Heat-treatment for heat-corrosion resistance determined.

High-temperature corrosion of alloy steels in combustion products of city gas—At U. of Michigan. Directed by Prof. A. E. White. Sponsored by Utilities Research Comm., Inc. Completed, 1932. Commercial alloys used. Results not published.

Oxidation of steel at elevated temperatures—At U. of Michigan. Directed by Prof. A. E. White and J. Chipman. Sponsored by The Timken Steel & Tube Co. Date of probable completion—1933. "Free Energy of the Oxides of Iron." J. Chipman, in "Ind. Eng. Chem.," 25 (1933).

Reactions between gases and metals at elevated temperatures — At U. of Michigan. Directed by Prof. A. E. White and J. Chipman. Sponsored by The Timken Steel & Tube Co. Completed, 1932; "Free Energy of Water, Carbon Monoxides, Carbon Dioxides, and Methane." J. Chipman, in "Ind. Eng. Chem.," 24, 1013 (1932).

Corrosion of metals at elevated temperatures — At U. of Michigan. Directed by Prof. A. E. White, W. E. Jominy and D. W. Murphy. Sponsored by Industrial Gas Research Committee-American Gas Assoc. "Equilibrium in the Iron-Oxygen-Hydrogen System at Temperatures above 1,000 deg. C." Jominy, W. E., and Murphy, D. W., in "Ind. Eng. Chem.," 23, 384-387 (1931).

Corrosion in piping carrying steam and hot water—At Johns Hopkins U. Directed by A. G. Christie.

Corrosion of iron pipes — At Johns Hopkins U. Directed by J. C. Smallwood. Sponsored by Johns Hopkins U. National Tube Co. In progress. To determine which material is least corroded by both hot and cold water.

Corrosion due to strain—At Columbia U. Directed by C. G. Fink. Sponsored by Columbia U. In progress. Investigation of effect of strain on corrosion of iron and steel.

Effect of corrosion on the fatigue limit of materials—At Brown Boveri & Co., Ltd., Baden, Switzerland. Sponsored by Brown Boveri & Co., Ltd. Completed 1932.

Effect of plastic deformation of aluminum alloys on their corrosion—At Metallurgical Inst., Aachen. Directed by P. Röntgen, Gillert. Sponsored by Aachen Technical College. In progress.

Effect of sulphur-bearing atmospheres upon steel—At U. of Michigan. Directed by Prof. A. E. White, Prof. C. Upthegrove, D. W. Murphy. Sponsored by Industrial Gas Research Committee-American Gas Assoc. In progress. "Behavior of Steel in Sulphur-Bearing Atmospheres." D. W. Murphy, in "Trans. Am. Soc. for Steel Treating" (1932).

Causes of corrosion of salt-water piping and best material therefor — At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by Lt. Comdr. H. S.

Klein, U.S.N. Sponsored by Bureau of Eng. and Bureau of Construction & Repair, Navy Dept. In progress.

Method of removing harmful and corrosive constituents from flue gas of a power plant—At U. of Illinois. Directed by H. F. Johnstone. Sponsored by Utilities Research Comm., Inc. In progress.

Effect of impure waters found in various sections of the country on water supply, steam and hot-water piping—At National Tube Co. Directed by F. N. Speller. Sponsored by Nat. District Heating Assoc.

Atmospheric corrosion tests of uncoated steel and iron sheet—At Annapolis. Sponsored by A.S.T.M. Comm. A-5. In progress. Report A.S.T.M. Comm. A-5, 1932. Tests at Pittsburgh and Fort Sheridan completed.

Corrosion tests on weld metal—At U. of Sheffield, Brown Firth Lab. and Royal Naval College. Sponsored by Inst. of Mech. Eng. In progress.

Corrosion tests of stainless steels — Sponsored by A.S.T.M. Comm. A-10. In progress. Report A.S.T.M., Comm. A-10, 1932. Laboratory corrosion tests restricted to four typical stainless steels and three corrosion tests of the inspection type.

Effect of texture on resistance of sheet copper to corrosion—At Inst. of Mech. Technology, Berlin. Directed by P. Riebensahm. Sponsored by Berlin College of Technology. In progress.

Corrosion of cable sheaths by A.C.—At British Elec. Research Assn. Sponsored by British Elec. Research Assn. To be published.

Corrosion of lead—At Metallurgical Institute, Berg-Akademie Freiberg. Directed by F. Brenthel. Sponsored by Berg-Akademie Freiberg. In progress.

Test of materials to resist corrosion for use in wet dust collector—At Riley Stoker Corp. Sponsored by Riley Stoker Corp. In progress. Has so far resulted in rejection or acceptance of certain materials.

Effect of combustion products on flues and chimneys—At U. of Illinois. Directed by A. C. Robertson. Sponsored by U. of Illinois and Utilities Research Comm., Inc. Completed. Publication to be a bulletin of Eng. Exp. Station.

Effect of chlorine water treatment on various metals in the condenser circulating system — At Detroit Edison Co. Sponsored by Detroit Edison Co. Completed, 1932.

Study of oil tank corrosion—At U. S. Bureau of Mines Sta., Bartlesville, Okla. Directed by H. C. Fowler. Sponsored by U. S. Bureau of Mines. In progress. U. S. Bureau of Mines Report of Investigation No. 3066 (1931), No. 3131 (1931), No. 3160 (1932).

Resistance of metals to wear—At Bureau of Standards. Sponsored by Bureau of Standards. In progress. "B.S. Jour. Research," Vol. 7, p. 419, 1931 (RP 348). Trans. Amer. Soc. for Steel Treating, Vol. 19, p. 247, 1932.

Wear of metals due to abrasion—At Ewart Works, Link-Belt Co. Directed by H. E. Hayward. Sponsored by Link-Belt Co. In progress. "Mechanical Engineering," Vol. 53, No. 9. Abrasion resistances of practically all existing materials have been compared with Key Steel, 0.08 to 0.12 carbon.

Oxidation by friction (a) of electrolytic copper, (b) electrolytic iron and pure nickel, (c) theory—At Materials Laboratory, Aachen. Directed by F. Rötscher, Fink. Sponsored by Aachen Technical College. (a) "Zeitschrift Metallkunde," Vol. 24, p. 49; (b) Completed, (c) Stahl und Eisen, Vol. 52.

Effect of chemical action on durability of boiler materials—At Materials Testing Bureau, Darmstadt. Directed by A. Thum, Holzhauer. Sponsored by Darmstadt Technical College. To appear end of 1932 in VDI "Verlag."

ELECTRICAL

Field tests to determine damping characteristics of synchronous generators—At General Electric Co. G. E. "Review," July, 1932, pp. 384-388, F. A. Hamilton, Jr.

Alternator field forms — At U. of Arkansas. Directed by Prof. W. B. Stelzner. Sponsored by U. of Arkansas. In progress. To be published.

Generator voltage when dropping load—At General Electric Co. "Elec. Eng.," March, 1932, pp. 160-163, E. J. Burnham. Tests show definitely that overvoltage can be prevented by use of high-speed regulators and bridge-type field rheostats, or by inserting resistance automatically in generator field circuit.

Generator overvoltage — At General Electric Co. "Elec. Eng.," March, 1932, pp. 163-167, J. W. Butler. Test results on an actual machine prove that the curve of overvoltage which may be calculated closely follows that secured in practice.

Power system frequency control with economical distribution of load among generating units — At Mass. Inst. of Tech. Directed by J. E. Mulligan. Sponsored by Mass. Inst. of Tech. Completed, 1932. Thesis.

Stability characteristics of synchronous machines—At General Electric Co. Directed by S. B. Crary and I. A. Terry. Sponsored by General Electric Co. To be published.

Effect on transient stability of adding series shunt resistances to generators at times of short circuit—At Mass. Inst. of Tech. Directed by A. D. Elwell. Sponsored by Mass. Inst. of Tech. Completed, 1932. Thesis.

Low-frequency self-exciting commutator generator—At General Electric Co. Sponsored by General Electric Co. A.I.E.E. Paper No. 33-34, J. I. Hull.

Generation of electricity by windmills—At U. of Saskatchewan. Directed by A. R. Greig. Sponsored by Natl. Research Council of Canada. In progress.

Conversion of sun energy into electrical energy—At Columbia U. Directed by C. G. Fink. Sponsored by Columbia U. In progress.

Commutation in D.C. machines—At General Electric Co. Directed by T. M. Linville. Sponsored by General Electric Co. To be published.

Commutation studies — At Westinghouse Elec. & Mfg. Co. Directed by L. R. Ludwig and R. M. Baker. Sponsored by Westinghouse Elec. & Mfg. Co. "Trans." A.I.E.E. Dec., 1932, p. 959.

Study of thyratron commutator motor—At General Electric Co. Sponsored by General Electric Co. G. E. "Review," Feb., 1933, pp. 76-80. Dr. C. H. Willis.

Dynamic braking of synchronous machines—At General Electric Co. Sponsored by General Electric Co. "Elec. Eng.," Dec., 1932, pp. 843-845, and A.I.E.E. paper No. 32-67, C. E. Kilbourne and I. A. Terry. Formulas for determining the number of revolutions and time required to stop a synchronous machine by dynamic braking are presented.

Operating performance of capacitor motors—At U. of Michigan. Directed by Prof. B. F. Bailey. Sponsored by U. of Michigan. In progress.

Starting performance of capacitor motors—At U. of Michigan. Directed by Prof. B. F. Bailey. Sponsored by Detroit Edison Co. Completed, 1931. Dept. of Eng. Research, U. of Michigan Bulletin No. 19 (1931).

Reduction of noise in single-phase fractional-horsepower induction motors—At U. of Michigan. Directed by Prof. F. A. Firestone and P. H. Geiger. Sponsored by Howell Electric Motors Co. In progress. Noise of motors was analyzed and a method of reducing the most important source of noise was devised for use in production.

Method of design for predetermining performance of shaded-pole motors—At Dept. of Elec. Eng., Ohio State U. Directed by E. E. Kimberly. Sponsored by Ohio State U. Eng. Exp. Station. In progress. Bulletin of the Eng. Exp. Station to be published. As a result of this research it is expected it will be possible to design a shaded-pole motor to fit a required set of performance characteristics.

Fan-cooled motor investigation—At U. of Maine. Directed by A. S. Hill. Sponsored by U. of Maine. In progress.

Percentage - differential transformer protection — At General Electric Co. Sponsored by General Electric Co. "Elec. Eng.," May, 1931, pp. 361-363, R. E. Cordray. Differential relays which operate on the phase difference between the currents in the different windings are particularly adapted to meet protection requirements.

Noise elimination in transformers—At Westinghouse Elec. & Mfg. Co. Directed by S. J. Mikina. Sponsored by Westinghouse Elec. & Mfg. Co. In progress. Study of the frequencies and amplitudes of transformer noises and development of means for reducing them to unobjectionable values.

Saturation phenomena in potential transformers—At General Electric Co.

Sponsored by General Electric Co. "Elec. Eng.," Feb., 1931, pp. 106-109, C. T. Weller. Experiences with grounded-neutral, Y-connected, potential transformers on ungrounded systems emphasize certain dangerous "saturation phenomena" which frequently occur.

Transformer insulation tests—At General Electric Co. G. E. "Review," Dec., 1932, pp. 649-653, L. Wetherill.

Oscillograph studies of transformer characteristics—At Purdue U. Directed by G. V. Mueller. Sponsored by Purdue Eng. Expt. Station. Published as Bulletin No. 37, Purdue Eng. Expt. Station.

Lightning protection of transformer secondaries—At Purdue U. Directed by C. F. Harding and C. S. Sprague. Sponsored by Utilities Research Comm., Inc. Completed, 1932. Published as Bulletin No. 42, Purdue Eng. Expt. Station.

Harmonic commutation for thyratron inverters and rectifiers — At General Electric Co. G. E. "Review," Dec., 1932, pp. 632-638, Dr. C. H. Willis.

Thyratron inverter operation and application—At Mass. Inst. of Tech. Directed by M. Smith and E. J. Shimek. Completed, 1931. Thesis.

Series-parallel type static converters—At General Electric Co. G. E. "Review," May, 1931, pp. 288-301, Sept., 1931, pp. 580-589, and Dec., 1931, pp. 738-744. C. A. Sabbah.

Mercury-arc rectifiers — At General Electric Co. "Elec. Eng.," Oct., 1931, pp. 788-793, Dr. A. W. Hull and H. D. Brown. Three factors most important in mercury-arc rectifiers are vapor pressure, arc-drop, and geometry of the anode housing.

Arc re-ignition investigation—At U. of Michigan. Directed by Profs. S. S. Attwood, W. G. Dow and G. Timoshenko. Sponsored by U. of Michigan. Completed, 1931. Published in "Trans." A.I.E.E. Vol. 50, 854 (1931). Potential distribution in arc space prior to re-ignition determined through cathode-ray study of 25-amp., 660-volt, 60-cycle 1-in. copper arc by means of probes.

Effect of type of circuits on arc-backs in mercury-arc rectifiers — At General Electric Co. Int. Elec. Congress, Paris, 1932, C. A. Sabbah. Generally accepted conception that lower frequencies are easier on rectifiers than higher ones is erroneous because peak inverse currents are higher for lower frequencies in a given circuit.

Probe measurements of D.C. copper arcs—At U. of Michigan. Directed by Prof. S. S. Attwood, Prof. W. G. Dow, and A. D. Forbes. Sponsored by U. of Michigan. In progress. The probe method provided a measurement of internal arc activity, of electronic gradients and of electronic temperatures up to 20,000 deg. C.

Probe measurements of A.C. arcs—At U. of Michigan. Directed by Profs. W. G. Dow, S. S. Attwood and G. S. Timoshenko. Sponsored by U. of Michigan. Completed, 1932. To be published in A.I.E.E. "Trans.," late 1933.

Precision methods for measuring high voltages—At Bureau of Standards. Sponsored by Bureau of Standards. In progress.

Measurement of resistance of storage-battery separators and the resistivity and viscosity of sulphuric acid solutions—At Bureau of Standards. Sponsored by Bureau of Standards. Reported at A.I.E.E. Convention, Jan. 26, 1933.

Effect of illumination on meter testing — At U. of Illinois. Directed by members of the Elec. Eng. faculty. Sponsored by U. of Illinois. Completed. "Elec. World," Vol. 100, No. 6, pages 180-181, Aug. 6, 1932.

Comparison of methods of calibrating polyphase watt-hour meters—At U. of Illinois. Directed by faculty members, Dept. of Elec. Eng. Sponsored by U. of Illinois. In progress. Progress report made to Meter Committee of N.E.L.A., April 13, 1932, and Sept. 6, 1932.

Effect of intermittent load on accuracy of watt-hour meter—At U. of Illinois. Sponsored by U. of Illinois. Testing apparatus has been assembled, and some tests have been made.

New portable oscillograph—At Westinghouse Elec. & Mfg. Co. Directed by K. A. Oplinger. Results to be published. This is a 2-element device which is portable and completely self-contained. It is arranged for visual work and for simultaneous photographic records.

Mercury circuit-breaker studies—At Purdue U. Directed by D. T. Canfield. Sponsored by Duncan Electric Mfg. Co. In progress.

Compression-type, low-voltage, air circuit breakers—At General Electric Co. Directed by D. C. Prince. Sponsored by General Electric Co. To be published.

Oil-blast circuit breaker—At General Electric Co. "Elec. Eng.," Feb., 1931, pp. 134-137, D. C. Prince and W. F. Skeats. A further development of the explosion-chamber principle avoids the mixing of arc and oil in the main gap.

Test results and circuit-breaker behavior—At General Electric Co. "Elec. Eng.," Sept., 1931, pp. 746-747. R. M. Spurck and H. E. Strang.

Kinematic solenoid-operated oil circuit breaker—At U. of Michigan. Directed by Prof. A. E. White and Prof. C. W. Good. Sponsored by Detroit Edison Co. Completed, July, 1931. Results reported to Detroit Edison Co.

Protection of rotating A.C. machines against traveling wave voltages — At General Electric Co. A.I.E.E. Paper No. 33-32, W. J. Rudgem, Jr., R. W. Wieseman and W. W. Lewis.

Effect of temperature on induction-type relay operation—At U. of Illinois. Directed by Elec. Eng. faculty. Sponsored by U. of Illinois. Apparatus has been assembled, and some data have been taken.

Plunger-type boric acid fuse — At Westinghouse Elec. & Mfg. Co. Directed by A. P. Strom, H. L. Rawlins. "Trans.," A.I.E.E., Dec., 1932, p. 1020. Handles up to 20,000 amps. at a voltage of 13 Kv. or higher.

Properties of impregnated paper insulators—At Johns Hopkins U. Directed by Dr. J. B. Whitehead. Sponsored by Utilities Research Comm., Inc. Completed, 1932; Published, A.I.E.E. "Trans.," Vol. 50, June, 1931.

Relative properties of winding insulations at different temperatures—At C. A. Parsons & Co. Ltd. Directed by J. Rosen. Sponsored by C. A. Parsons & Co. Ltd. Not completed.

Chemical research in insulating materials—At General Electric Co. "Elec. Eng.," Jan., 1932, pp. 30-32, F. M. Clark.

Changes in physical and electrical properties of mineral insulating oil heated in contact with air—At General Electric Co. "Jnl. Phys. Chem.," July, 1932, pp. 1928-1941, H. H. Race.

Fundamental characteristics of liquid dielectrics—At Bureau of Standards. Directed by Dr. H. L. Curtis. Sponsored by Utilities Research Comm., Inc. Completed, 1933.

Variations with temperature and frequency of dielectric loss in a viscous mineral insulating oil—At General Electric Co. "Phys. Rev.," Feb. 15, 1931, pp. 430-446, H. H. Race.

Non-inflammable insulating fluids—At General Electric Co. Directed by F. M. Clark. Sponsored by General Electric Co. To be published.

Weatherproof insulation of line wires—At Purdue U. Directed by C. F. Harding, L. L. Carter, J. W. Olsen, R. N. Shreve. Sponsored by Utility Research Comm., Inc. Completed, 1932. Published as Bulletin No. 43, Purdue Eng. Expt. Sta.

Impulse tests on solid insulation—At Purdue U. Directed by C. S. Sprague. Sponsored by Purdue Eng. Expt. Sta. In progress.

Methods of testing high-voltage cables to determine whether satisfactory for power circuit service—At U. of Illinois, Dept. Elec. Eng. Directed by Prof. E. B. Paine. Sponsored by U. of Illinois, Utilities Research Commission, Inc. In progress. Publication of results is in progress.

Current-carrying capacity of V.I.R. cables in steel conduits—At British Elec. Research Assn. Sponsored by British Elec. Research Assn. To be published.

Current-carrying capacity of cables passing through ironwork—At British Elec. Research Assn. Sponsored by British Elec. Research Assn. To be published.

Grounding electrical circuits in high-resistance soils — Inter-company research, Chicago district. Directed by A. Herz. Sponsored by Utilities Research Comm., Inc. In progress.

Current-carrying capacity of long vertical cables — At British Elec. Research Assn. Sponsored by British Elec. Research Assn. To be published.

Current-carrying capacity and impedance of V.I.R. and paper-insulated lead-sheathed cables—At National Physical Lab. Sponsored by British Elec. Research Assn. To be published.

Current-carrying capacity of deeply buried cables—At North-Eastern Electric Supply Co., Ltd. Directed by E. M. Fawssett. Sponsored by British Elec. Research Assn. To be published.

Insulators under power arc conditions—At British Elec. Research Assn. Spon-

sored by British Elec. Research Assn. To be published.

Varnished tapes for electrical purposes—At Metropolitan-Vickers Electrical Co., Ltd., British Thomson-Houston Co., Ltd., H. D. Symons & Co., Ltd. Sponsored by British Elec. Research Assn. To be published. To form the basis of a British Standard Specification.

Filling Compounds — At National Physical Laboratory, Metropolitan-Vickers Electrical Co., Ltd. Sponsored by British Elec. Research Assn. To be published. To form the basis of a British Standard Specification.

Impregnated asbestos boards — At Metropolitan-Vickers Electrical Co., Ltd. Sponsored by British Elec. Research Assn. To be published. To form the basis of a British Standard Specification.

Varnishes for electrical purposes—At Metropolitan-Vickers Electrical Co. Ltd., British Thomson-Houston Co., Ltd. Sponsored by British Elec. Research Assn. To be published. To form the basis of a British Standard Specification.

Study of electrical properties of foreign and domestic micas—At Bureau of Standards. Sponsored by Bureau of Standards. "B. S. Jour. Research," Vol. 7, p. 403, 1931 (RP 347).

Corona losses between wires at extra high voltage—At Purdue U. Directed by C. F. Harding and C. S. Sprague. Sponsored by Purdue Eng. Exp. Sta. In progress.

Inflammable gases produced by thermal decomposition of plastic insulators—At U. S. Bureau of Mines, Pittsburgh Exp. Sta. Directed by W. P. Yant. Sponsored by U. S. Bureau of Mines. Completed. U. S. Bureau of Mines Report of Investigation 3194 (1932).

Testing alternator rotor forgings—At C. A. Parsons & Co., Ltd. Sponsored by C. A. Parsons & Co., Ltd. "The Electrical Times," June 9, 1932. The use of a "Borescope" also described.

Magnetic transmission over parallel cylindrical paths—At U. of Minnesota. Directed by A. O. C. Nier. Sponsored by U. of Minnesota. In progress.

Magnetic properties of binary and ternary alloys of nickel, cobalt and iron—At National Physical Lab. Sponsored by British Elec. Research Assn. To be published.

Influence of magnetic fields on aging of hardened steel—At Metals Institute, Berlin. Directed by A. Hanemann, A. Kussmann and H. J. Wiester. Sponsored by Berlin Technical College. To be published. "Archiv Eisenhüttenwesen."

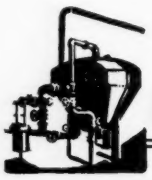
Fundamental research on ferromagnetism—At Westinghouse Elec. & Mfg. Co. Directed by T. D. Yensen, F. Bitter, S. L. Burgwin, A. A. Frey, N. A. Ziegler. "Trans. A.I.M.E." 1931-32 (3 papers). "Elec. Jrnl." 1931 "Trans. Am. Electro-chem. Soc.," 1932. Establishing magnetic and related properties of pure iron and pure iron alloys.

Measuring core loss at high densities—At General Electric Co. "Elec. Eng.," Jan., 1932, pp. 36-38, B. M. Smith and C. Concordia. The refined method now available for densities up to 20,000 gausses is recommended as standard.

Measurement of stray load loss in polyphase induction motors—At General Electric Co. "Elec. Eng.," Apr. 1932, p. 265, C. J. Koch.

Delayed recording of electrical disturbances (obtaining initial portion of record)—At Purdue U. Elec. Eng. Lab. Directed by C. F. Harding, R. H. George. Sponsored by Utilities Research Comm., Inc. Started, 1933.

Brazed joints for electric conductors—At General Electric Co. "Elec. Eng.," June, 1931, pp. 434-436, Samuel Martin, Jr. Electric-resistance brazing produces in electric conductors joints which possess several distinct advantages over equivalent soldered joints and can be made at a lower cost.



FEED WATER

Methods of boiler water analyses with a view toward establishing methods suitable for recommendation as standard—At U. of Michigan. Directed by Prof. A. H. White, W. C. Schroeder and C. W. Fellows. Sponsored by Boiler Feed Water Studies Committee (Amer. Boiler Mfg. Assoc., Amer. Railway Eng. Assoc., A.W.W.A., N.E.L.A., A.S.T.M., A.S.M.E.). In progress. Published in "Ind. Eng. Chem.," Anal. Ed. 4, 271-83 (1931), Sub-Committee No. 8, Report to A.S.M.E., Am. Water Works Assoc. (1932). A new and rapid method for the determination of sulphate has been successfully developed. Present research is studying the various methods available for determining dissolved oxygen in boiler waters.

Quantitative analysis of solutions by spectroscopic means—At U. of Michigan. Directed by Prof. O. S. Duffendack, F. A. Wiley and J. S. Owens. Sponsored by U. of Michigan. In progress—date of completion, 1933. To be published. Technic developed for analysis of solutions of the chlorides, sulphates and phosphates of Mg, Ca, Na and K in concentrations from 0.001 to 0.05 per cent.

SO_4 to CO_3 ratio for the prevention of sulphate boiler scale—At U. of Michigan. Directed by Prof. A. H. White and W. C. Schroeder. Sponsored by Detroit Edison Co. Completed, 1932. Published in Report Sub-Committee No. 8, A.S.M.E. An extended discussion of this investigation of the SO_4-CO_3 ratio will appear in "Ind. and Eng. Chem."

Caustic embrittlement failures—At U. of Michigan. Directed by Prof. A. E. White and R. Schneidewind. Sponsored by Detroit Edison Co. Completed. 1931. "Trans. A.S.M.E.," 53: 193-214 (1931). The failures due to caustic embrittlement have been identified and their characteristics studied.

Prevention of feed line scales, molecularly dehydrated phosphates, and reduction of alkalinity in boiler water—At Hall Laboratories, Inc.

Boiler feed-water treatment for prevention of scale, corrosion, etc.—At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by Lt. Comdr. T. A. Solberg, U. S. N., Chemical Engineer R. C. Adams. Sponsored by Bureau of Eng., Navy Dept. (and July, 1931-July, 1932, jointly by U. S. Shipping Board). In progress. It appears possible, by suitable conditioning of water, to remove old scale and inhibit scale and corrosion.

Effect of pressure and temperature on behavior of salts in boiler feed water—At U. of Illinois. Directed by F. G. Straub. Sponsored by Utilities Research Comm., Inc. Completed, 1933.

Boiler water conditioning at high pressures—At Hall Laboratories, Inc. In progress.

Solubility studies of boiler waters (both high and low pressures)—At U. of Illinois, Eng. Exp. Station. Directed by F. G. Straub. Sponsored by U. of Illinois and Utilities Research Commission, Inc. In progress. Study includes investigation of scale formation, corrosion, embrittlement and carry-over.

Deposition of solids in water-wall system—At Rilev Stoker Corp. Sponsored by Riley Stoker Corp. Completed. Resulted in changing location of blowdown valve to remove solids.

Boiler feed-water conditioning in Western Oregon—At Mech. Eng. Dept., Oregon State College. Directed by Prof. R. E. Summers. In progress; to be completed 1933. To be published. All surface waters are soft with freedom from ordinary types of scale, but produce considerable silica scale.

FLUID FLOW

Metering viscous fluids with thin plate orifice — At Case School of Applied Science. Directed by G. L. Tuve. Sponsored by Case School of Applied Science, Bailey Meter Co. cooperating. In progress.

Effects of flows and pressure drops on balanced valves—At Northern Equipment Co. Directed by W. L. Hunter, H. H. Weining, V. V. Veenschoten. Sponsored by Northern Equipment Co. In progress.

Coefficients of discharge for concentric orifices in pipes of sizes from 1 to 15 in. Coefficients were determined simultaneously for the various standard pressure tap locations used in this country and for the German Standard Tap Locations—At Dept. of Mech. Eng., Ohio State U. Directed by S. R. Beitler. Sponsored by A.S.M.E., A.G.A., Bailey Meter Co. and Ohio State U. Eng. Exp. Station. Completed Feb. 1, 1933. Preliminary report presented to A.S.M.E. in 1931—Paper No. R.P.—54-3. Published values for coefficients of discharge for concentric orifices have been found to be slightly erroneous for large and small pipe sizes and new and more accurate values have been found.

Water flow through sharp-edged orifices—At U. of Maine. Directed by W. J. Sweetser. Sponsored by U. of Maine. In progress.

Fluid flow through circular orifices—At Purdue U. Directed by F. W. Greve. Sponsored by Purdue U. In progress. Fluids used were water, oil of different densities and several sugar solutions.

Discharge through thin-plate orifices in pipe lines—At W. Virginia U. Directed by L. V. Carpenter. Sponsored by W. Virginia U. In progress. Six sizes of orifices in 2 in. pipe line have been tested.

Flow of liquids through minute orifices—At Pennsylvania State College. Directed by P. H. Schweitzer. Sponsored by Pennsylvania State College. In progress. Development of a viscosity correction for flow of oils of high viscosity through diesel orifices.

Flow over triangular or V-Notch weirs—At U. of Wisconsin. Directed by F. M. Dawson and A. T. Lenz. Sponsored by U. of Wisconsin. In progress.

Dynamics of suppressed weir discharge—At River Hydro Lab. of Mass. Inst. Tech. Directed by Hunter Rouse. Sponsored by Mass. Inst. of Tech. In progress. To show relation between pressure distribution in nappe and shape of nappe. Ratio of head on crest to depth of approach.

Trajectory of nappe from suppressed sharp-crested weir and pressure on face of weir—At U. of California. Directed by O. Shaughnessy and Peterson. Sponsored by U. of California. Completed. Thesis.

Broadcrested weirs—At U. of California. Directed by Bartlett and Carter. Sponsored by U. of California. To be completed, 1933. Thesis.

Flow over weirs with rounded crests—At Hydraulisches Inst. der Technischen Hochschule, München. Directed by Dr. D. Thoma. Sponsored byNotgemeinschaft der Deutschen Wissenschaft. To be published.

Fluid meter tests on highly viscous fluids—At U. of Oklahoma. Directed by W. H. Carson. Sponsored by A.S.M.E. Mid-Continent Section and U. of Oklahoma. In progress. To determine accuracy of existing coefficients and correction factors for varying viscosity of fluids.

Subviscous flow—At Pennsylvania State College. Directed by P. H. Schweitzer. Sponsored by Pennsylvania State College. In progress. An investigation into the deviations from the Poiseuille law for liquids flowing at a low rate of shear through minute openings.

Correlation of data on friction factors in smooth pipe, and study of non-isothermal velocity distribution in pipes—At Mass. Inst. of Tech. Directed by W. H. McAdams, E. C. Koo, T. B. Drew. Sponsored by M.I.T. Chem. Eng. Lab. Presented before Am. Inst. Chem. Eng., Schenectady Meeting. Graduate thesis.

Friction drop in commercial pipe fittings—At U. of Michigan. Directed by Prof. W. L. Badger and Prof. W. L. McCabe. Sponsored by U. of Michigan. In progress. To be published.

Loss of head in welding fittings—At U. of Alabama. Directed by J. M. Gallalee. Sponsored by Crane Co. Completed.

Losses in crooked conduits of diverse forms—At Aerodynamic Institute, Danzig. Directed by G. Flügel, W. Spalding. Sponsored by Danzig Technical College. Completed; to appear in "Zeitschrift VDI."

Loss of head in pipe bends—At National Hydraulic Lab. Directed by K. H. Beij and G. H. Keulegan. Sponsored by U. S. Bureau of Reclamation. In progress. Installation for tests on 4-in. steel tubing with commercial bends now being set up.

Tests with hot-wire instrument for direction and velocity of flow of water—At Hydraulic Institute, Munich. Directed by D. Thoma, T. Sen. Sponsored by Munich Technical College. Completed. In preparation for printing.

Hydraulic effect of various conditions of operation upon different forms of piezometers. Operation compared with reference orifice—At Worcester Polytechnic Inst. Directed by C. M. Allen, L. J. Hooper. Complete, "Trans." A.S.M.E., HYD-54-1.

Development of Pitot tube or equivalent device sensitive to the direction of flow of a gas—At Gordon McKay Lab., Harvard Eng. School. Directed by Prof. Marks. Sponsored by Prof Marks. Recently completed. Two instruments have been devised, both of which determine the direction of flow of a gas with an accuracy of about 1 deg. and both of which will give accurate impact pressure readings.

Measurement of velocity of fluid flow—At U. of Minnesota. Directed by H. E. Hartig, H. B. Wilcox. Sponsored by U. of Minnesota and A.S.M.E. In progress. "Physical Review," Vol. 29, No. 3, March, 1927, page 485. Effect of fluid velocity on the propagation of sound waves in fluids may be used to measure the fluid velocity with considerable accuracy.

Application of salt velocity method of water measurement to short pipes and penstocks—At Worcester Polytechnic Inst. Directed by C. M. Allen. Sponsored by Worcester Polytechnic Inst. In progress.

Laws of hydraulic similitude—At U. of Minnesota. Directed by L. G. Straub. Sponsored by U. of Minnesota. In progress. Limitations of the laws of hydraulic similitude investigated.

Model draft-tube studies for the purpose of determining the law of similitude—At Hydraulic Lab. of Princeton U. Directed by C. T. Tench. Sponsored by Princeton U. To be continued. Due to limitation of water available, investigation did not quite indicate whether Froude or Reynolds laws apply in stepping up results of model tests.

Visualization of air flow by means of light beam—At U. of Minnesota. Directed by J. D. Akerman. Sponsored by U. of Minnesota. In progress.

Flow of saturated air through thin sharp-edged orifices, for use in rating and testing vacuum return pumps.—At the U. of Detroit. Directed by F. J. Linsenmeyer.

Gaseous flow in tubes at abrupt enlargement of cross-section—At Heat-engine Lab., Munich. Directed by W. Nusselt. Sponsored by Munich Technical College. In progress.

Effect of orifice installation on meter accuracy for gas lines—At South Columbus Metering Station, Ohio Fuel Gas Co. Directed by S. R. Beitler and J. E. Overbeck. Sponsored by A.G.A., A.S.M.E., and Ohio State U. Eng. Exp. Sta. In progress; not published. Results show meter errors of as much as 4 per cent are caused by present commercial orifice flanges and that certain limits as to orifice size must be offered to keep measurements within allowable limits of accuracy.

Methods of measuring high-temperature gases flowing in ducts, pipes, tube banks, etc.—At Columbia U. Directed by C. E. Lucke. Sponsored by Columbia U. In progress.

Flow of air through orifices—At U. of Illinois. Directed by faculty Mech. Eng. Sponsored by U. of Illinois. Completed on circular orifices with rounded approach and on thin-plate, circular orifices with sharp edges. Bulletins Nos. 207 and 240, Eng. Exp. Station, U. of Illinois. Third bulletin in preparation.

Air flow through poppet valves—At Mass. Inst. of Tech. Directed by C. F. Park. Sponsored by M.I.T. Mech. Eng. Dept. Thesis. Not published.

Investigation of the variation in velocity head of air flowing through duct—At Gordon McKay Lab. of Harvard Eng. School. Directed by Prof. Marks. Sponsored by Prof. Marks. In progress. The object of this investigation is to ascertain how nearly the actual flow corresponds to the theoretical flow and the magnitude of the errors involved in following standard test methods.

Pulsations of air flow along a duct—At Gordon McKay Lab. of Harvard Eng. School. Directed by Prof. Marks and Mr. Flint. Sponsored by Prof. Marks. In progress. This investigation is concerned at present with the development of an instrument to permit an analysis of the frequencies and intensities of the pulsation waves in the duct.

Flow of natural gas through transmission lines—At U. S. Bureau of Mines, Bartlesville, Okla. Directed by H. C. Fowler. Sponsored by U. S. Bureau of Mines, Amer. Gas Assoc. U. S. Bureau of Mines Report of Investigation No. 3153 (1931). In progress.

Quantity measurements of fluids of small "Reynolds numbers"—At Machinery Lab., Danzig. Directed by E. Schmidt, H. G. Giese. Sponsored by Danzig Technical College. Completed; to appear in "Forschung." Measurements by means of nozzles and screens.

String anemometer for extremely small air velocities—At Institute for Hydraulic Research, Berlin. Directed by H. Föttinger, May. Sponsored by Berlin Technical College. In progress.

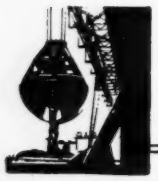
Calibration of large gas meters in place—At Mass. Inst. of Tech. Directed

by T. A. Mangelsdorf. Sponsored by Utilities Research Comm., Inc. In progress.

Discharge coefficients of short tubes—At U. of California. Directed by Jones & Twigg. Sponsored by U. of California. To be completed, 1933. Thesis.

Hydraulic conditions in lateral spillway channels—At Mass. Inst. of Tech. Sponsored by Mass. Inst. of Tech. In progress. Work done on a 20-ft. flume with level bottom having constant cross-section 9 in. wide, 2 ft. deep.

Corrections to be made in measurement of stream-line flow—At Lafayette College. Directed by E. C. Bingham. Sponsored by Lafayette College. In progress. To be published in "Jnl. of Rheology."



FUELS

Grindability of coal—At U. of Michigan. Directed by Prof. A. E. White, Prof. E. S. Pettyjohn and R. W. Fahrig. Sponsored by U. of Michigan. In progress. To be published. A fair index of the relative hardness of coal can be obtained by sizing after grinding for 500 revolutions in a 1-gal. abbé ball mill using 500 grams of crushed coal and a pebble load of 2,500 grams.

Methods for rating grindability of coal—A Canada Dept. of Mines, Fuel Research Lab. Sponsored by Mines Branch, Fuels & Fuel Testing Div., in co-operation Sub-Com. 7, Comm. D-5 A.S.T.M. Progress report, Feb., 1933. A new laboratory method having some promise has been developed.

Grindability of coal—Influence of fuel type on energy required for grinding coal—At Mason Lab., Yale U. Directed by W. J. Wohlenberg. Sponsored by W. J. Wohlenberg. In progress.

Grinding—At Columbia U. Directed by L. T. Work. Sponsored by Columbia U. A.S.M.E. Buffalo Meeting, June, 1932, "An Analysis of Crushing and Pulverizing Processes." Analysis of the forces causing fracture of particles in grinding.

Sampling pulverized coal—At U. of Washington. Completed, 1932.

Production of pulverized coal—At Regent Street Polytechnic. London. Sponsored by Inst. of Mech. Eng. and Regent St. Polytech.

Absorption as a method for determining surface of pulverized coal—At Battelle Memorial Inst. Directed by R. A. Sherman. Sponsored by Battelle Memorial Inst. Completed, 1933. To be published in "Proc. A.S.T.M."

Coal ash fusibility as related to clinker formation—At U. S. Bureau of Mines, Pittsburgh Exp. Sta. Directed by P. Nicholls. Sponsored by U. S. Bureau of Mines and Carnegie Inst. of Tech. Completed. U. S. Bureau of Mines Bulletin 364.

Effect of relative temperatures of ash fusion on coals used and in boiler furnaces—At U. of Michigan. Directed by Prof. G. G. Brown. Sponsored by U. of Michigan. Completed, 1932. Boiler furnace temperature must be below ash fusion temperature of coal used for uniform operation of station.

Determination of fusibility of coal ash and interpretation of results in terms of furnace operation—At Northern States Power Co. Completed, 1932.

Power plant survey to develop information concerning the performance of different kinds of fuel and equipment—Field work throughout the State of Ohio. Directed by H. M. Faust. Sponsored by Ohio Coal Investigation Committee and Ohio State U. Eng. Exp. Sta. Started in 1931—in progress. Not published.

Tests of various fuels for heating systems—At U. of Wisconsin. Directed by G. L. Larson, D. W. Nelson, H. G. Jones, J. E. Dow and A. L. Groth. Sponsored by U. of Wisconsin. Completed, June, 1932. U. of Wisconsin master's thesis.

Ohio coal investigation—At Ohio State U. Eng. Exp. Sta. Directed by H. M. Faust. Sponsored by Ohio Coal Investigation Comm., Dept. of Industrial Relations of the State of Ohio and Ohio State U. Eng. Exp. Sta. Bulletin 75, Ohio State U. Eng. Exp. Sta., Cambridge (Ohio No. 7 seam) 1¼ in. nut and slack coal was used during a series of six 24-hour tests on a 7-retort underfeed stoker, set with a refractory walled furnace to fire a 6,000-sq.ft. boiler. The results show this coal performed satisfactorily over a range of 28 to 47 lb. per sq.ft. of projected grate per hour with over-all efficiencies of 73 to 66 per cent.

Investigation of the bituminous coals of Nova Scotia, relating to the improvement of storage properties through washing or other special preparation—At Canada Department of Mines (Fuel Research Lab.). Sponsored by Mines Branch, Fuels & Fuel Testing Div., in cooperation with Dominion Steel & Coal Corp. and Montreal Coke & Mfg. Co. Observation tests at commercial plant conducted on large quantities of coal and preliminary report issued. Washing and sizing Nova Scotia coals heretofore liable to heating and burning when stored in large piles, render these coals immune from heating or spontaneous combustion and permit them to be stored with perfect safety in large piles.

Investigations and researches in coal—At Canada Dept. of Mines Fuel Research Lab. Directed by John McLeish, and B. F. Haanel. Sponsored by Mines Branch, Fuels & Fuel Testing Div. Constantly in progress. Reports released periodically.

Analyses of coals—At U. S. Bureau of Mines, Pittsburgh Exp. Sta. Directed by A. C. Fieldner. Sponsored by U. S. Bureau of Mines. U. S. Bureau of Mines Tech. Papers Nos. 484 (1931), 491 (1931), 529 (1932).

Plastic state of coal during coking—At U. S. Bureau of Mines, Pittsburgh Exp. Sta., and Northwest Exp. Sta., Seattle, Wash. Directed by J. D. Davis, W. A. Selvig and H. F. Yancey. Sponsored by U. S. Bureau of Mines. U. S. Bureau of Mines Tech. Papers 512 (1932), "Ind. & Eng. Chem.," Vol. 23 (1931). In progress.

Methods of determining the friability of coal—At U. S. Bureau of Mines, Northwest Exp. Sta., Seattle, Wash. Directed by H. F. Yancey. Sponsored by U. S. Bureau of Mines and U. of Washington. U. S. Bureau of Mines Tech. Paper 512 (1932).

Drying of coal—At College of Mines, Leoben. Directed by Müller, Skutl. Sponsored by Leoben College of Mines. "Zeitschrift Elektrochemie u. anorganische Chemie."

Drying of various coals—At Lignite Research Institute, Berg-Akademie Freiberg. Directed by K. Kegel, Säuberlich. Sponsored by Berg-Akademie Freiberg. To be completed, middle of 1933.

Drying of peat—At College of Mines, Leoben. Directed by Müller, F. Bayer. Sponsored by Leoben College of Mines. "Zeitschrift Elektrochemie u. anorg. Chemie."

Sulphur removal from coal—At U. of Illinois. Directed by R. D. Snow. Sponsored by U. of Illinois and Utilities Research Comm., Inc. Work started 1931; not in progress. Publication in "Indus. & Engrg. Chem."

Washing Illinois coal to reduce ash and sulphur—At U. of Illinois. Directed by Dr. R. D. Snow. Sponsored by Utilities Research Comm. Completed, 1932.

Sulphur forms in Virginia coals—At Virginia Polytechnic Inst. Directed by F. H. Fish and J. A. Addlestone. Sponsored by Virginia Eng. Exp. Sta. Bulletin No. 7 of Virginia Eng. Exp. Sta.

Correlation of available hydrogen content of liquid fuels and their carburetting value—At U. of Michigan. Directed by Prof. A. H. White and Peter Merkus. Sponsored by Michigan Gas Assn. In progress. It is feasible to measure the combined hydrogen of fuels in a modified bomb calorimeter, and the correlation between available hydrogen and carburetting value of liquid fuels is being studied.

Competitive relation of coal and petroleum in the United States—At Mass. Inst. of Tech. Directed by W. S. Hutchinson, A. J. Breitenstein. Sponsored by M.I.T. Dept. of Mining & Metallurgy. A.I.M.E. Contribution No. 18. Feb., 1933. Graduate thesis.

Fuel oil investigation—At U. S. Naval Eng. Exp. Station, Annapolis. Directed by Lieut. R. R. Gurley, J. G. O'Neill. Sponsored by Bureau of Eng., Navy Dept. In progress.

Rates of pressure rise and knock rating of gasoline—At Penn. State College, Mech. Eng. Lab. Directed by Profs. Everett and Stewart. Sponsored by Pennsylvania State College, Dept. of Mech. Eng. In progress. Results not published.

Detonation characteristics of motor fuels—At Bureau of Standards. Sponsored by Nat'l. Auto. Chamber of Commerce, Amer. Petroleum Institute. In progress.

Ignition characteristics of diesel fuels—At Bureau of Standards. Sponsored by A.S.M.E. and S.A.E. Proposed.

Composition of petroleum—At Bureau of Standards. Sponsored by Bureau of Standards. In progress. Thirty-one published papers.

Utilization of waste natural gas—At U. S. Bureau of Mines, Pittsburgh Exp. Sta., and Petroleum Exp. Sta., Bartlesville, Okla. Directed by H. H. Storch and H. C. Fowler. Sponsored by U. S. Bureau of Mines. Report of Investigation 3143 (1931), Information Circular 6388 (1931).

Conversion of technological gases into power sources—At Lignite Research Institute, Berg-Akademie Freiberg. Directed by R. V. Walther. Sponsored by Berg-Akademie Freiberg. In progress.

Inflammability of gases and vapors—At U. S. Bureau of Mines, Pittsburgh Exp. Sta. Directed by G. W. Jones. Sponsored by U. S. Bureau of Mines. U. S. Bureau of Mines Bulletin 279 (1931), U. S. Bureau of Mines Technical Paper 544 (in preparation), U. S. Bureau of Mines Report of Investigation 3172 (1932).

HEAT TRANSFER

Radiant heat transmission between surfaces separated by non-absorbing media—At Mass. Inst. of Tech. Directed by H. C. Hottel. Sponsored by M.I.T. Fuel Eng. Lab. Published by A.S.M.E. F.St. P. 53-19e (1931) 265.

Measurement of radiation from non-luminous gases and flames. Measurement of total radiation from hot gases—At Mass. Inst. of Tech. Directed by Prof. H. C. Hottel. Sponsored by National Research Council, Comm. on Heat Transfer.

Radiation in boiler furnaces—At Mason Lab., Yale U. Directed by W. J. Wohlenberg. Sponsored by W. J. Wohlenberg. In progress. Essay for degree of Master of Science in Mech. Eng., June, 1932.

Radiation in water furnace—At Mason Lab., Yale U. Directed by Francis E. Dorsey. Sponsored by W. J. Wohlenberg. In progress. To be published in "Trans." of Northeast Coast Inst. of Eng. & Shipbuilders, Newcastle-on-Tyne.

Heat transmission in radiant sections of tube stills—At Mass. Inst. of Tech. Directed by D. W. Wilson, W. E. Lobo, H. C. Hottel. Sponsored by M.I.T. Fuel Eng. Lab. "Industrial & Eng. Chem.," Vol. 24 (1932) 46.

Effect of reradiation on heat transmission in furnaces and through openings—At Mass. Inst. of Tech. Directed by H. C. Hottel, J. D. Keller. Sponsored by M.I.T. Fuel Eng. Lab. Presented A.S.M.E. Dec. Meeting, N. Y., 1932.

Total radiation of (a) steam up to 1,000 deg C.; (b) CO_2—At Machinery Lab., Danzig. Directed by E. Schmidt. Sponsored by Danzig Technical College. (a) "Forschung," Vol. 3, p. 57; (b) in progress.

Radiation from flames—At Machinery Lab., Danzig. Directed by E. Schmidt, J. Werneburg. Sponsored by Danzig Technical College. In progress.

Heat transfer between steam on the outside of a tube and water flowing within the tube under different conditions—At Cornell U. Directed by C. F. Hershfeld. Sponsored by Nat. Research Council Comm. on Heat Transmission.

Effect of tube diameter on heat transfer to boiling liquids—At U. of Michigan. Directed by Prof. W. L. Badger. Sponsored by U. of Michigan. In progress, date of completion; Oct. 1933. Apparatus complete and running.

Heat transfer from metals to boiling liquids—At U. of Michigan. Directed by Prof. W. L. Badger. Sponsored by U. of Michigan. In progress; date of completion, 1937. Apparatus complete.

Heat transmission to water flowing in tubes of different lengths—At Worcester Polytechnic Institute. Directed by Thomas K. Sherwood. Sponsored by National Research Council, Comm. on Heat Transfer.

Heat transfer from a horizontal hot tube to cold water—At Heat Engine Lab., Munich. Directed by W. Nusselt, G. Ackermann. Sponsored by Munich Technical College. "Forschung," Vol. 3, p. 42. Transfer under conditions of normal convection.

Heat transfer in connection with heaters, coolers (both condensing and non-condensing), heat interchangers and surfaces used in connection with the evaporation of liquids and the absorption of vapors, both with gases and liquids on the other side of the surface—At Carrier Engineering Corp. Directed by Donald Franch.

Heat transfer through condensing vapor films—At U. of Michigan. Directed by Prof. W. L. Badger. Sponsored by U. of Michigan. In progress; date of completion, Oct. 1933. Apparatus has been perfected, in many respects beyond any previous attempts to measure these coefficients.

Heat transfer attending viscous and turbulent flow of liquids in pipes, turbulent flow of air outside and at right angles to pipes, mean delta T in multipass heat exchangers, etc.—At Mass. Inst. of Tech. Directed by W. H. McAdams, T. B. Drew, T. K. Sherwood, W. P. Ryan, W. M. Nagel, J. J. Hogan, E. C. Koo. Sponsored by M.I.T. Chem. Eng. Lab. "Trans." Am. Inst. Chem. Eng. **26** (1931) 26. "Trans." Am. In. Chem. Eng. **26** (1931) 81, "Trans." Am. In. Chem. Eng. **26** (1931) 118, "Ind. Eng. Chem." **24** (1932) 273.

Transmission of heat from steam to air, the air blowing through tubes—At Carrier Eng. Corp. Directed by R. M. Stikeleather. Sponsored by Committee on Heat Transmission of National Research Council.

Heat transfer of finned tubes with forced air circulation—At Case School of Applied Science. Directed by G. L. Tuve, G. A. McKeeman. Sponsored by Case School of Applied Science, A.S.H.V.E. cooperating. In progress.

Heat transfer in fin-type unit coolers—At Buffalo Forge Co. Sponsored by Buffalo Forge Co. In progress.

Heat transfer in ribbed air-coolers—At Machinery Lab., Karlsruhe. Directed by R. Plank, Th. E. Schmidt. Sponsored by Karlsruhe Technical College. Nearing completion.

Heat transfer factors in a gas unit heater—At U. of California. Directed by A. G. Foote. Sponsored by U. of California, Pacific Coast Gas Assn. "Proceedings," Pacific Coast Gas Assn., Aug. 25, 1932.

Heat transfer in fan-cooled motors—At U. of Michigan and U. of Minnesota. Directed by Prof. A. D. Moore and Prof. A. S. Hill. Sponsored by Reliance Electric & Eng. Co. In progress. To be published.

Rate of heat transfer in a fire-tube heater—At Mass. Inst. of Tech. Directed by J. Holt. Sponsored by M.I.T. Mech. Eng. Dept. In progress.

Laws governing heat flow through built-up wall sections and insulating materials—At U. of Minnesota. Directed by Frank B. Rowley.

Heat transfer tests on various insulating materials, including air space. Test samples 4 ft. by 5 ft. and used with temperatures as low as —40 deg. F. and wind velocity up to 20 m.p.h.—At U. of Saskatchewan. Directed by A. R. Grieg. Sponsored by Nat. Research Council of Canada.

Heat flow through single and double glazing—At Pittsburgh, Pa. Directed by R. A. Miller, M. L. Carr. Sponsored by Pittsburgh Plate Glass Co. In progress. Double glazing materially reduces heat losses.

Heat transmission through building materials — At U. of Minnesota. Directed by F. B. Rowley and A. B. Algren. Sponsored by U. of Minnesota and A.S.H.V.E. In progress. Bulletin No. 8, Eng. Exp. Station, U. of Minnesota, 1932. Heat transmission coefficients determined for walls used in average building construction. Surface transmission coefficients are given for various types of surfaces at different wind velocities and temperatures. Air-space coefficients are determined for air spaces up to 3½ in.

Heat transmission through building materials, insulating maetrials, pipe coverings and refractories, using both flat plate and hot box methods—At Armour Inst. of Tech. Directed by J. C. Peebles.

Transmission of heat through the roof of a building—At Agricultural & Mech. College of Texas. Directed by F. E. Giesecke. Sponsored by Texas Eng. Exp. Sta.

Heat transmission through pipe covering and refractory materials at high temperatures — At Pennsylvania State College. Directed by F. G. Hechler and E. R. Queer.

Comparative tests on heat transmission in refractories—At Brooklyn Polytechnic Inst. Directed by E. F. Church, Jr.

Conductimeter for measuring heat

transfer through walls of actual buildings—At Bureau of Standards. Sponsored by Bureau. In progress.

Development and application of the heat flow meter—At Pennsylvania State College. Directed by F. G. Hechler and E. R. Queer.

Heat conductivity by hot-box method—At U. of Detroit. Directed by F. J. Linsenmeyer.

Film conductance coefficients for various surfaces in still and moving air—At U. of Minnesota and A.S.H.V.E. Lab. Sponsored by A.S.H.V.E.

Determination of heat transfer coefficients for frosted surfaces—At Pennsylvania State College. Directed by F. G. Hechler and E. R. Queer.

Transfer of heat through air spaces—At Pennsylvania State College. Directed by E. R. Queer. Sponsored by Pennsylvania State College. H.P.A.C., Vol. 3, No. 11, pp. 960-965, Nov., 1931. Shows that radiation is the most important factor and that aluminum foil may be arranged to give a high thermal resistance. Shows the effect of height and width of air spaces on heat transfer.

Heat transfer from diphenyl vapors to oils (both mineral and vegetable)—At U. of Michigan. Directed by Prof. W. L. Badger. Sponsored by U. of Michigan. In progress; date of completion, 1934. Apparatus under construction.

Diphenyl and diphenyl oxide vapors as heating media—At U. of Michigan. Directed by Prof. W. L. Badger. Sponsored by U. of Michigan; In progress; partly completed. U. of Michigan Bulletin No. 23 (1932); Diphenyl, diphenyl oxide, or mixtures of the two, are practical as heat transfer media up to 750 deg. F., and probably higher. Boiler designs have been tested in the laboratory and a safe and practical design established. Chief advantages of the system are high rates of heat transfer, positive and accurate temperature control, and diminution of local overheating.

Solutions as heat transfer agents—At U. of Michigan. Directed by W. H. Sellew. Sponsored by U. of Michigan. Projected.

Measurement of heat transfer of gases at velocities up to and above sound—At Brown Boveri & Co., Ltd., Baden, Switzerland. Sponsored by Brown Boveri & Co., Ltd. In progress. Results applied to pressure-fired boilers.

Heat transfer coefficients in evaporating viscous liquids—At U. of Michigan. Directed by Prof. W. L. Badger. Sponsored by U. of Michigan. In progress; date of completion, 1933. For very viscous liquids, a log-log plot of over-all heat transfer coefficients vs. viscosity gives a straight line when velocity and temperature drop are constant. Lines for different temperature drop are straight and parallel. When viscosity is expressed as viscosity at mean film temperature, lines for all temperature drops coincide. Difference in material being evaporated may make a slight difference in slope of lines.

Effect of humidity on heat transfer at temperatures above and below freezing—At U. of Tennessee. Sponsored by U. of Tennessee. In progress. A.S.R.E. spring meeting, Chicago, 1933.

Determination of the film coefficients for various pressures, temperatures, heat flow and other variables for the common types of refrigerants—At Penn. State College. Directed by J. H. Anderson and R. M. Alexander in collaboration with Profs. Everett, Hechler, Queer and Stewart. Sponsored by the Pennsylvania State College, Dept. of Mech. Eng. In progress. Results not published.

Heat transfer in ammonia compressor—At Heat Engine Lab., Munich. Directed by W. Nusselt, G. Wirth. Sponsored by Munich Technical College. Completed.

Methods of collection and interpretation of heat transfer data — At Mass. Inst. of Tech. Directed by C. W. Berry, W. W. Soroka. Sponsored by M.I.T. Mech. Eng. Dept. Thesis. Not published.

HEATING & VENTILATING

Pipe capacity in hot-water heating systems—At Texas Ag. & Mech. College. Directed by F. E. Giesecke. Sponsored by Texas A. & M. and A.S.H.V.E. In progress. Number of papers published in "A.S.H.V.E. Jnl."

Flow of condensate and air in steam heating returns—At Carnegie Inst. of Tech. Directed by F. C. Houghten, Carl Gutberlet. Sponsored by A.S.H.V.E. "Jnl. A.S.H.V.E.," Dec., 1932. Friction coefficients for flow of air-water mixtures determined.

Condensate and air in steam heating system returns—At Carnegie Inst. of Tech. Directed by F. C. Houghten, J. L. Blackshaw. Sponsored by A.S.H.V.E. Presented A.S.H.V.E., 1932. Determined air condensate ratio and heating up time in actual installations.

Capacity of pipe for steam heating systems—At Carnegie Inst. of Tech. Directed by A. C. Jewett, C. M. Humphreys. In cooperation with the Research Laboratory of A.S.H.V.E.

Warm air heating research, with forced-air circulation—At U. of Illinois. Directed by faculty, Mech. Eng. Dept. Sponsored by U. of Illinois, Nat. Warm Air Heating Assn. Bulletins Nos. 112, 117, 120, 141, 188, 189, 230 and 246, and Circular No. 15, Eng. Exp. Station. Investigation concerned with study of various factors affecting design and operation of forced air heating plants, and also with use of air washers.

Water vapor refrigeration using steam jet — At Ingersoll-Rand Co., Phillipsburg, N. J. Directed by F. H. Hibberd. Sponsored by Ingersoll-Rand Co. In progress.

Heating an experimental room by means of refrigeration—At U. of Pittsburgh. Directed by J. A. Dent. Thesis.

Relative cost of operating hot water and steam heating systems—At Texas Ag. & Mech. College. Directed by F. E. Giesecke. Sponsored by Texas Eng. Exp. Sta.

Low-temperature radiant heating — At Westinghouse Elec. & Mfg. Co. Directed by L. W. Schad. "Domestic Eng.," Jan., 1933, p. 47. Experiments on low-temperature wall and ceiling heating of rooms produced electrically.

Air infiltration through steel framed windows—At U. of California. Directed by D. O. Rusk, V. H. Cherry and L. M. K. Boelter. Sponsored by A.S.H.V.E. Completed, "Jnl. A.S.H.V.E.," Oct., '32.

Infiltration of air into buildings—At U. of Wisconsin. Directed by G. L. Larson, D. W. Nelson, R. W. Kubasta, W. M. Richtman and C. Bratz. Sponsored by U. of Wisconsin and A.S.H.V.E. In progress. Engrg. Exp. Sta. Reprints Nos. 12, 17, 19, 23.

Surface absorption of heat from solar radiation—At Pennsylvania State College. Directed by F. G. Hechler, E. R. Queer. Sponsored by Pennsylvania State College. "Refrigerating Eng.," Vol. 25, No. 2, pp. 86-91, Feb., 1933.

Effect of heat capacity and conductance of a structure, on heat flow into a building from solar radiation—At A.S.H.V.E. Research Lab., Pittsburgh. Directed by F. C. Houghten.

Heat gain to windows and walls due to sunlight — At Carrier Engineering Corp. Directed by Donald Franch.

Heat emission of concealed hot-water radiators at different mean temperatures—At U. of Toronto. Directed by R. W. Angus.

Performance of steam and hot-water radiators for heating purposes—At Bureau of Standards. Sponsored by Bureau of Standards. In progress.

Rates of heat transfer and condensation in a unit cooler—At Mass. Inst. of Tech. Directed by J. Holt. Sponsored by M.I.T. Mech. Eng. Dept. In progress.

Characteristics of unit heaters using superheated steam compared with performance when using saturated steam. Study will be made of capacities and transfer coefficients for various types of surfaces operated under various air conditions—At Mech. Eng. Lab., Penn. State College. Directed by R. D. Fellows. Sponsored by Penn. State College, Dept. of Mech. Eng. Construction of set-up now complete and preliminary tests being run.

Unit heater testing—At Armour Inst. of Tech. Directed by Prof. Lynn E. Davies.

Effect of size and spacing of fins on heat transmission from extended surface radiators—At Pennsylvania State College. Directed by F. G. Hechler and E. R. Queer.

Tests of automatic temperature control—At Brooklyn Polytechnic Inst. Directed by E. F. Church, Jr.

Temperature and humidity control in industrial buildings equipped with unit air conditioners—At U. of Michigan. Directed by Prof. R. S. Hawley. Sponsored by Consolidated Paper Co. In progress; date of completion, 1933.

Effect of cold walls on air temperature for feeling of comfort—At A.S.H.V.E. Lab., Pittsburgh. Directed by F. C. Houghten. Sponsored by A.S.H.V.E. Presented annual meeting, 1933.

Minimum air requirements for ventilation and air conditioning—At Harvard U. Directed by C. P. Yaglou.

Artificially ionized air, physiologic and biochemical effects—At Harvard U. Directed by C. P. Yaglou. In progress.

Methods of artificial ionization—At Harvard U.

Air conditioning and ventilation research—At Mass. Inst. of Tech. Directed by J. Holt. Results to be published in "A.S.H.V.E. Jnl."

Air conditioning and cooling—At U. of Michigan. Directed by W. H. Sellew and Prof. W. L. McCabe. Sponsored by U. of Michigan. In progress; to be published.

Determination of the cooling capacity of refrigeration units—At Pennsylvania State College. Directed by A. H. Zerban.

Refrigeration requirements in summer cooling—At U. of Illinois. Directed by Mech. Eng. faculty. Sponsored by U. of Illinois, A.S.H.V.E. and Nat. Warm Air Heating Assoc. In progress; "Jnl. A.S.H.V.E.," Feb., 1933.

Air velocities, quietness of operation and duct equalization in a forced-circulation warm-air heating system—At U. of Michigan. Directed by Prof. R. S. Hawley. Sponsored by Economy Baler Co. In progress; date of completion, 1933.

Sound production in relation to air-conditioning equipment—At Carrier Engineering Corp. Directed by Donald Franch.

Tests to determine practical method for testing air-cleaning devices—At U. of Minnesota. Sponsored by A.S.H.V.E. In progress; results used to prepare A.S.H.V.E. test code.

Measurement of relative humidity—At General Electric Co. To be published. F. S. Marcellus.

Air measurements: (a) laboratory tests, (b) commercial ventilating systems—At Armour Inst. of Tech. Directed by Prof. Lynn E. Davies.

Influence of outlet vents on ventilation—At U. of Wisconsin. Directed by G. L. Larson, D. W. Nelson. Sponsored by U. of Wisconsin, A.S.H.V.E. "Jnl. A.S.H.V.E.," June-July, 1932.

Air flow through registers and grilles—At Armour Inst. of Tech. Directed by L. E. Davies. Sponsored by Armour Inst. of Tech., A.S.H.V.E. In progress. Study of methods for measuring air flow from registers and grilles. Study of methods of determining delivery from unit ventilators.

Effect of crowds and air movement on air stratification in confined spaces—At U. of Wisconsin. Directed by G. L. Larson, D. W. Nelson, O. C. Cromer and R. W. Kubasta. Sponsored by U. of Wisconsin and A.S.H.V.E. In progress.

Study of direct and indirect radiation—At U. of Illinois. Directed by A. C. Willard. Sponsored by U. of Illinois, A.S.H.V.E. In progress. Bulletins Nos. 169, 192, 193, reprint No. 1 Eng. Exp. Sta. Performance characteristics of various types of convectors in room heating test plant. Performance of convectors in test booth as provided in A.S.H.V.E. code—Correlation of results.

Charting temperature field of heat radiators — At Machinery Laboratory, Danzig. Directed by E. Schmidt. Sponsored by Danzig Technical College. "Forschung," Vol. 3, p. 181.

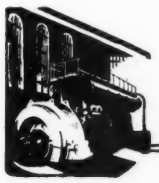
Thermostatic steam traps in steam heating systems—At U. of Detroit. Directed by F. J. Linsenmeyer.

Vacuum return pumps for steam heating systems—At U. of Detroit. Directed by F. J. Linsenmeyer.

Efficiency and economy study of underground steam distribution systems—At U. of Tennessee. Sponsored by U. of Tennessee. In progress. Work includes a 4-year service test on one underground system.

Study of proposed ventilation system of new Chicago Subway—At U. of Illinois. Directed by W. H. Severns, C. G. Bradley. Sponsored by U. of Illinois, Chicago Subway Commission. Eng. Expt. Sta. Bulletins. A full-size ventilation tower has been constructed where study is made of various types of air discharge nozzles.

Vehicular tunnel ventilation—At Mass. Inst. of Tech. Directed by J. Holt. Sponsored by M.I.T. Mech. Eng. Dept. Thesis; not published.



DIESEL ENGINES

Effect of variations in viscosity and Conradson carbon of fuel oils on operation of diesel engines—At Submarine Base, New London. Sponsored by A.S.M.E. Comm. on Diesel Fuel Oil Specifications, L. H. Morrison. In progress.

Mechanism of atomization—At Bureau of Standards. Sponsored by Bureau of Standards. Completed. Nat'l. Adv. Comm. for Aero., Tech. Report No. 440.

Formation and dispersion of oil sprays—At Pennsylvania State College. Directed by P. H. Schweitzer, K. J. De Juhasz and O. F. Zahn, Jr. Sponsored by Pennsylvania State College; Engineering Experiment Station. Bulletin No. 40, Aug., 1932. Effect of oil pressure, air pressure and liquid properties upon dispersion.

Penetration of oil sprays—At Pennsylvania State College. Directed by P. H. Schweitzer. Sponsored by Pennsylvania State College. In progress.

Pressure fluctuations in injection lines of diesel engines—At Pennsylvania State College. Directed by P. H. Schweitzer, K. J. De Juhasz. Sponsored by Pennsylvania State College. In progress.

Geometry of fuel-injection systems—At Pennsylvania State College. Directed by P. H. Schweitzer.

Characteristics of the Robert Bosch fuel-injection system—At Pennsylvania State College. Directed by K. J. De Juhasz.

Jet injection for diesel engines — At Machinery Laboratory, Dresden. Directed by R. Mollier, A. Nägel, W. Pauer, O. Holfelder. Sponsored by Dresden Technical College. "Forschung," Vol. 3, p. 229.

Fuel injection with spark ignition in an Otto cycle engine—At Mass. Inst. of Tech. Directed by C. F. Taylor, E. S. Taylor and G. L. Williams. Sponsored by M.I.T. Aeronautical Dept. S.A.E. "Journal," March, 1931, and January, 1932.

Combustion in an engine cylinder—At Bureau of Standards. Sponsored by Nat'l. Adv. Comm. for Aero. In progress.

Combustion during the compression-ignition cycle—At Mass. Inst. of Tech. Directed by M. S. Huckle. Sponsored by M.I.T. Aeronautical Dept. and H. M. Crane. In progress.

Combustion phenomena in diesel engines—At Combustion-Engine Laboratory, Stuttgart. Directed by W. Maier, W. Lieb. Sponsored by Stuttgart Technical College. First part published; second part in progress.

Flame propagation in diesel engines—At Heat-Engine Laboratory, Munich. Directed by W. Nusselt, K. Prell. Sponsored by Munich Technical College. In progress.

Combustion in the mixing chamber of diesel engines — At Heat-Engine Laboratory, Munich. Directed by W. Nusselt, F.v.d. Nahmer. Sponsored by Munich Technical College. Completed.

Pressure produced in the ring-groove back of piston ring—At U. of Minnesota. Directed by B. J. Robertson and A. R. Ford. Sponsored by U. of Minnesota. In progress.

Expansion of light piston alloys—At Aerodynamic Institute, Aachen. Directed by C. Wieselsberger, Bollenrath. Sponsored by Aachen Technical College. To be published in "Zeitschrift Metallkunde."

Piston ring and cylinder liner materials—determination of best materials—At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by J. B. Lincoln, W. C. Stewart. Sponsored by Bureau of Eng., Navy Dept. In progress.

Leakage past piston rings as affected by accuracy of machining — At Mech. Eng. Lab., Penn. State College. Directed by Prof. H. A. Everett. Sponsored by Penn. State College, Dept. Mech. Eng. In progress.

Effect of piston rings on piston friction—At Mech. Eng. Lab., Penn. State College. Directed by Prof. H. A. Everett. Sponsored by Penn. State College, Dept. Mech. Eng. In progress.

Exhaust temperature of four-cycle diesel motors — At Machinery Lab., Karlsruhe. Directed by R. Plank, Bangerter. Sponsored by Karlsruhe Technical College. Nearing completion.

Oscillations in exhaust pipes of combustion engines — At Machinery Lab., Danzig. Directed by E. Schmidt, Th. Schmidt. Sponsored by Danzig Technical College. In progress.

Scavenging in two-cycle engines—At Combustion Engine Lab., Stuttgart. Directed by W. Maier, O. Lutz, Sponsored

by Stuttgart Technical College. First part published in Reports of Combustion Engine Lab.; second part in progress.

Scavenging in various two-cycle, high-speed diesel motors — At Combustion Motor Laboratory, German Technical College, Prag. Directed by K. Körner, E. Schindler. Sponsored by German Technical College, Prag. To be completed end of 1932.

Piezo-electric measurement of pressure in internal-combustion engines—At Signal Current Lab., Stuttgart. Directed by J. Herrmann, Widmer. Sponsored by Stuttgart Technical College. In progress.

Indicating high-speed, internal-combustion engines—At Heat Engine Lab., Munich. Directed by W. Nusselt, E. Kallhardt. Sponsored by Munich Technical College. In progress.

Development of piezo-electric indicator for high-speed internal-combustion engines—At Mass. Inst. of Tech. Directed by H. F. King. Sponsored by M.I.T. Mech. Eng. Dept. In progress.

Diesel engine researches: (a) injection, (b) spectrum analysis—At Institute for Combustion Engines, Hannover. Directed by K. Neumann, Mehlig, Beck. Sponsored by Hannover Technical College. (a) Completed, 1932; (b) in progress.

Pressure variations inside the cylinders of internal-combustion engines—At McGill U. Directed by D. A. Keys. Sponsored by Nat. Research Council of Canada. To be published.

Pressure waves within the cylinder of an internal-combustion engine, particularly during detonation—At Mass. Inst. of Tech. Directed by C. S. Draper. Sponsored by M.I.T. Aeronautical Dept. In progress. Strong pressure waves during detonation appear to conform to predicted acoustic properties. Calculation of cylinder pressures for a wave frequency may be possible.

Optical phenomena occurring within the cylinder of an internal-combustion engine—At Mass. Inst. of Tech. Directed by J. Elting. Sponsored by M.I.T. Aeronautical Dept. (Sloan Automotive Fellowship.) In progress. Methods of attack employing high-speed photography or a series of photo-electric cells have shown promise.

Vapor pressure of diesel fuels—At Bureau of Standards. Sponsored by Nat'l. Auto. Chamber of Commerce, Amer. Petroleum Inst. Completed. In press.

Octane numbers vs. engine performance—At Oregon State Ag. College. Directed by W. H. Paul and W. V. Hanley. Sponsored by Oregon State College Eng. School. Completed Dec., 1932. Regardless of speed or load, detonation causes a loss of power, and as detonation is decreased by raising the octane number of the fuel, a corresponding increase in power results until all detonation is removed.

Behavior of fuels and lubricants in internal-combustion engines—At Lab. for Liquid Fuels, Breslau. Directed by A. W. Schmidt. Sponsored by Breslau Technical College. Published.

Researches on compressorless high-speed diesel engines — At Machinery Lab., Breslau. Directed by H. Baer, H. Neumann. Sponsored by Breslau Technical College. Initial experiments completed.

Heat distribution and heat flow in an air-cooled, internal-combustion engine—At Mass. Inst. of Tech. Directed by C. F. Park. Sponsored by M.I.T. Mech. Eng. Dept. Thesis. Not published.

Heat transfer in diesel engine cylinders—At Heat Engine Lab., Munich. Directed by W. Nusselt, v. Faber du Faur. Sponsored by Munich Technical College. In progress.

Performance characteristics of high-speed diesel engines—At U. of Michigan. Directed by Prof. H. E. Keeler. Sponsored by U. of Michigan. In progress. Further work on design and operation of fuel pumps and fuel nozzles to high-speed diesel engines will improve fuel economy and operating characteristics.

Effect of dimensions of mixing chamber on efficiency of diesel engine — At Lab. for Combustion Engines, Graz. Directed by W. Heyn. Sponsored by Graz Technical College. In progress.

Engine performance at high compression ratios—At U. of Michigan. Directed by Prof. A. E. White, Prof. W. Lay, and H. E. Zuck. Sponsored by U. of Michigan. Completed, 1931. U. of Michigan Circular No. 5 (1931).

Effect of air humidity on engine performance—At Bureau of Standards. Directed by Navy Dept. Sponsored by Bureau of Standards. In progress. Nat'l. Adv. Comm. for Aero., Tech. Report No. 426.

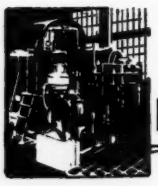
Torque requirements of diesel injection pumps—At Pennsylvania State College. Directed by K. J. De Juhasz. Sponsored by Pennsylvania State College. In progress.

Modulus of elasticity in torsion of steel as applied to crankshafts—At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by W. C. Stewart. Sponsored by Bureau of Eng., Navy Dept. In progress.

Effect of spark character on ignition —At Bureau of Standards. Sponsored by Nat'l. Adv. Comm. for Aero. and Navy Dept. In progress. "B.S. Jnl. Research," Vol. 9, p. 81, 1932 (RP 460).

Internal friction in gasoline engines—At U. of Arkansas. Directed by Prof. L. C. Price. Sponsored by U. of Arkansas. In progress. To be published.

Positive metering and distribution of gasoline in internal-combustion engines —At U. of Arkansas. Directed by Prof. L. C. Price. Sponsored by U. of Arkansas. In progress; to be published.



LUBRICATION

Determination of oiliness characteristics of oils made from different crudes and by various fractionations—At Mech. Eng. Lab., Penn State College. Directed by A. H. Zerban, Dr. M. R. Fenske. Sponsored by Pennsylvania State College, Dept. of Mech. Eng. and Dept. of Chemistry. In progress, to be completed, 1933. Present indications are that the remodeled machine will give consistent results on a given sample of oil so that accurate tests may be conducted.

Correlation between oiliness of lubricating oils and nature of the material of the bearing surfaces—At Hydraulisches Inst. der Technischen Hochschule, Munchen. Directed by Dr. D. Thoma. Sponsored by Notgemeinschaft der Deutschen Wissenschaft. To be published.

Heat of friction in automotive engine bearings—At Mass. Inst. of Tech. Directed by C. F. Park. Sponsored by M.I.T. Mech. Eng. Dept. Thesis; not published.

Limiting conditions of fluid friction in bearings under oscillating load—At Machinery Lab., Karlsruhe. Directed by R. Plank, Hein. Sponsored by Karlsruhe Technical College. "Petroleum," Vol. 28, Part 19, p. 1.

Friction of some babbitt, roller and ball bearings — At U. of Wisconsin. Completed. Bulletin 72, U. of Wisconsin.

Friction in bearings — At Inst. for Power Eng., Braunschweig. Directed by F. Meyenberg, Gösser. Sponsored by Braunschweig Technical College. Published in 1932. Effect of the kinds of metal used in bearings.

Friction in greased bearings with greases of various consistencies — At Machinery Lab., Karlsruhe. Directed by R. Plank, v. Schroeter. Sponsored by Karlsruhe Tech. College. Complete 1933.

Effect on different metals of sliding friction under superheated steam — At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by Lt.-Comdr. V. H. Godfrey. Sponsored by Bureau of Eng., Navy Dept. In progress.

Frictional characteristics of a series of representative lubricating oils tested on the grooved specimen, Herschel, Kingsbury and Timken oiliness machine —At U. S. Bureau of Standards. Sponsored by A.S.M.E. Completed. Results indicate quantitive values depend on design of machine and mode of operation.

Extreme pressure lubricants—At Bureau of Standards. Sponsored by S.A.E. In progress. "Bulletin" Amer. Petroleum Inst., Dec., 1932—Sect. III.

Lubricating oils under high pressure —At Machinery Lab., Breslau. Directed by H. Baer, Hassenbach, Kallmünzer, Leu. Sponsored by Breslau Technical College. Completed and published.

Viscosity of lubricating oils—At U. of Michigan. Directed by Prof. S. Goudsmit and J. S. Owens. Sponsored by U. of Michigan. In progress; date of completion, 1933. To be published. Linear relationship between viscosity and temperature developed for lubricating oils and mixtures of lubricating oils.

Effect of distillation on properties of lubricants—At Columbia U. Directed by L. T. Work. Sponsored by Columbia U. In progress.

POWER'S RESEARCH TABLE

Relative characteristics of new and reclaimed crankcase oil—At U. of Wisconsin. In progress; project S15.

Effect of high temperature on lubricating properties of oils—At Institute for Operating Science, Braunschweig. Directed by F. Meyerberg, Ruegenberg. Sponsored by Braunschweig Technical College. Published.

Properties of solid filled lubricants—At Columbia U. Directed by L. T. Work. Sponsored by Columbia U. Thesis investigations by W. Glinsmann and A. A. Triska, unpublished. Has shown the effect of particle size of zinc oxide and soaps and of percentage upon viscosity and wetting characteristics of lubricants.

Clarification of oils—At Columbia U. Directed by C. G. Fink. Sponsored by Columbia U. Doctor's dissertation by Herbert Waterman, "Electrical Precipitation of Suspended Particles from Oils and Other Viscous Liquids." In progress.

Oxidation of crankcase oils—At Bureau of Standards. Sponsored by Bureau of Standards and A.S.T.M. In progress.

Lubrication of journal bearings—At Bureau of Standards. Directed by A. E. Flowers. Sponsored by A.S.M.E. In progress.

Process of lubrication in high-speed bearings of commercial size — At Machinery Lab., Dresden. Directed by E. Heidebroek and co-workers. Sponsored by Dresden Technical College. Part 1, VDI "Forschungsheft" 352. In progress.

Research on cylindrical bearings—At Steam-Turbine Lab., Stuttgart. Directed by A. Wewerka. Sponsored by Stuttgart Technical College. Completed, 1932.

Lubrication of gears—At Bureau of Standards. Sponsored by Bureau of Standards. In progress.

Influence of oil pressure, quantity and distribution on performance of thrust bearings—At Brown Boveri & Co., Ltd., Baden, Switzerland. Sponsored by Brown Boveri & Co., Ltd. In progress. To be published in "Brown Boveri Review."

Problems on the lubrication of vertical journals—At U. of California. Directed by A. I. Ponomareff, Everett D. Howe. Sponsored by U. of California. Published by A.S.M.E.

Thin-film lubrication—At Bureau of Standards. Sponsored by Bureau of Standards. In progress. "Bull. Amer. Petroleum Inst.," Dec., 1932—Sect. III.

Investigation of apparatus for testing lubricating oils and metals for bearings—At Machinery Lab., Karlsruhe. Directed by R. Plank, Filsinger. Sponsored by Karlsruhe Technical College. In progress.

Development of a method by which the metallic wearing of bearings can be quantatively determined by successive analyses of the metal contamination in the oil—At Penn. State College, Mech. Eng. Lab. Directed by Profs. Everett, Stewart, Fenske and J. Mikita. Sponsored by Pennsylvania State College, Dept. Mech. Eng. In progress.

Method of determining the stability of lubricating oils—At U. S. Bureau of Mines, Petroleum Exp. Sta., Bartlesville, Okla. Directed by H. C. Fowler. Sponsored by U. S. Bureau of Mines. In progress.

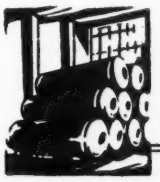
Lubrication technique—At General Electric Co. "Refrig. Eng.," Nov., 1932, pp. 268-272. B. L. Newkirk.

Method for rapid determination of iodine count in commercial lubricating oils — At German Technical College, Brünn. Directed by E. Galle, Böhm. Sponsored by German Technical College, Brünn. "Erdol, Teer," Vol. 8, pp. 76 and 91.

Vibrations in sliding bearings — At Machine Design Lab., Darmstadt. Directed by G. Bleibtreu. Sponsored by Darmstadt Technical College. In progress.

Pressures, temperatures and flow in the oil film between irregular surfaces (gear teeth, roll bearings, etc.) with sliding and rolling friction — At General Machinery Lab., Dresden. Directed by E. Heidebroek and associates. Sponsored by Dresden Technical College. In progress.

Bearing bronzes — At Battelle Memorial Inst. Directed by O. E. Harder. Sponsored by Copper & Brass Research Assn., in cooperation with Non-Ferrous Bearing Metal Research Group. Completed, 1933. Mechanical properties of Cu-Sn-Pb bearing alloys were studied. Existing specifications for such alloys were tabulated and their requirements compared with the properties actually obtained in such alloys.



MATERIALS

Properties of metals at high temperatures—At Westinghouse Elec. & Mfg. Co. Directed by P. G. McVetty, A. Nadai. Published by A.S.M.E., Dec., 1932; A.S.M.E., June, 1932. This involved the study of the factors affecting choice of working stresses for high-temperature service.

High-temperature corrosion and strength characteristics of heat-resisting Fe, Ni, Cr, alloys — At International Nickel Co., D. & R. Dept. Sponsored by International Nickel Co. In progress. Particular attention given to sulphurous atmospheres.

Influence of high temperatures on properties of materials to be machined—At Materials Testing Bureau, Darmstadt. Directed by A. Thum and Holdt. Sponsored by Darmstadt Technical College. In progress; preliminary report in "Maschinenschaden," Vol. 8, p. 17.

Metals at high temperatures—At General Electric Co. Paper presented at A.S.M.E., Dec. 5, 1932. E. L. Robinson. Test procedure and data.

Embrittlement of steels under conditions of prolonged temperature and stress — At U. of Sheffield, England. Sponsored by Inst. of Mech. Eng. and U. of Sheffield. In progress.

Elastic properties of steel at elevated temperatures—At Mass. Inst. of Tech. Directed by J. H. Zimmerman, H. H. Langdon. Sponsored by M.I.T. Mech Eng. Dept. In progress.

Impact strength and structural stability of "18-8" stainless steel at elevated temperatures — At Bureau of Standards. Sponsored by Bureau of Standards in cooperation with High-Temperature Res. Comm., A.S.T.M.-A.S.M.E. "Proc.," A.S.T.M., Vol. 32, Part 1, 1932, pp. 156-166, pp. 170-192.

High-temperature properties of 18 Cr-8 Ni steel—At Battelle Memorial Inst. and U. of Illinois. Directed by H. W. Gillett. Sponsored by A.S.M.E., A.S.T.M., Engineering Foundation, National Research Council, producers and consumers, Joint Committee (of A.S.M.E. and A.S.T.M.) on Effect of Temperature on the Properties of Metals—H. J. French, chairman. Work on creep at high temperatures at Battelle and endurance at high temperatures at Illinois. In progress.

Durability tests at high temperatures—At Materials Testing Lab., Stuttgart. Directed by E. Siebel, Ulrich. Sponsored by Stuttgart Technical College. In progress.

Steels at high temperatures—At National Physical Lab. Sponsored by British Elec. Research Assn. In cooperation with the National Federation of Iron & Steel Mfrs.

Properties of metals at elevated temperatures — At Bureau of Standards. Sponsored by Bureau of Standards. In progress. "B. S. Jnl. Research," Vol. 9, p. 327, 1932 (RP474); and Vol. 9, p. 441, 1932 (RP481).

Flow of steels at elevated temperatures—At General Electric Co. "Trans." A.S.M.E., June 15, 1932, APM 54-6.

Creep test of ferrous and non-ferrous metals at elevated temperatures—use of photo-electric cell—At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by Comdr. G. B. Vroom, U.S.N., Lieut. H. E. Haven, U.S.N., W. C. Stewart, J. D. Irons. Sponsored by Bureau of Eng., Navy Dept. In progress.

Flow of steel at high temperatures—At Mass. Inst. of Tech. Directed by F. H. Norton. Sponsored by Babcock & Wilcox Co. To be published.

Creep characteristics of carbon and alloy steels at 1,000 deg. F.—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by The National Tube Co. In progress; date of probable completion, 1933.

Effect of method of loading on the resultant creep characteristics of ferrous metals—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by Detroit Edison Co. In progress; date of probable completion, 1933. Creep resistance appreciably affected by method of loading.

Influence of recrystallization temperatures and grain size upon creep characteristics of non-ferrous alloys at elevated temperatures—At U. of Michigan. Directed by Prof. A. E. White and C. L.

Clark. Sponsored by Detroit Edison Co. Completed, 1932. "Trans.," A.S.T.M. (1932).

Creep characteristics of metals at elevated temperatures—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by U. of Michigan. In progress. "Trans.," Am. Soc. Steel Treating (1932).

Resistance to creep of forged and cast steels under variable loads and variable elevated temperatures—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by Allis-Chalmers Mfg. Co. Completed, 1931. Varying either the load or the temperature decreases the resistance to creep of both forged and cast steels.

Resistance of forged steel to single and up-step creep tests at 850 deg. F.—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by Allis-Chalmers Mfg. Co. Completed, 1931. Forged steels show a slightly greater resistance to creep under the up-step method of loading.

Creep characteristics of calite alloys at 1,600-2,000 deg. F.—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by Calorizing Co. In progress. Calite alloys are capable of sustaining loads from 3,200 lb. per sq.in. at 1,600 deg. F. to 450-750 lb. per sq.in., at 2,000 deg. F. with a creep rate of one per cent per 10,000 hr.

Creep of metals under torsion—At U. of Sheffield. Sponsored by Inst. of Mech. Eng. and U. of Sheffield. In progress.

Creep characteristics of ferrous and non-ferrous metals by the Barr and Bardgett method—At U. of Michigan. Directed by Prof. A. E. White, C. L. Clark. Sponsored by Detroit Edison Co. Completed, 1933. No continuity in relationship appears to exist between results from this method and the usual types of creep tests when various types of steel are used.

Creep tests of ferrous metals in shear—At U. of Michigan. Directed by F. L. Everett. Sponsored by U. of Michigan. In progress. "Trans.," A.S.M.E. 51, 1931; "Physics," April, 1933. Creep tests of metals in shear eliminate effect of fluctuations of temperature on strain measurements which are normally experienced in tensile creep tests. Accelerated tests obtained by over-loading followed by substantial subsequent reductions to normal test load.

Flow of solids, creep—At Lafayette College. Directed by E. C. Bingham, Markus Reiner. Sponsored by Lafayette College. In progress. To be published "Jnl. of Rheology."

Methods of creep testing—At Battelle Memorial Inst. Directed by H. W. Gillett. Sponsored by Battelle Memorial Inst. In progress. Precautions necessary to get consistent and reliable results in testing metals for creep at elevated temperatures are studied, magnitude of different variables evaluated, and improved equipment designed.

Crystalline structure in flow of metals subjected to repeated stresses—At U. of Maine. Directed by H. D. Watson. Sponsored by U. of Maine. In progress.

Stresses in chromium-nickel steel—At U. of Illinois. Directed by H. F. Moor. Sponsored by U. of Illinois, National Research Council. In progress. "Proc.," A.S.T.M., Vol. 31, Part 1, p. 114. Creep strength becomes the dominant factor rather than fatigue strength above about 1,000 deg. F.

Effect of high-pressure and temperature on alloy steels for valve construction, particularly for seats and disks—At Crosby Steam Gage & Valve Co., Research Dpt. Sponsored by Crosby Steam Gage & Valve Co. In progress; not published. Tests conducted at 3,000-lb. steam pressure. Determination of creep, distortion, bearing qualities, etc., of the steels, tested under these conditions.

Development of high nickel content anti-galling cast alloys for valve trim and other high-temperature service—At International Nickel Co., D. & R. Dept. Sponsored by International Nickel Co. In progress.

High-temperature properties of nickel steels for valves, bolts, blades, etc.—At International Nickel Co., D. & R. Dept. Sponsored by International Nickel Co. In progress.

Steels for high-temperature purposes—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by The Timken Steel & Tube Co. In progress. This investigation has led and is leading to the development of high-temperature-resisting commercial steels and alloys.

High-strength alloys for high-temperature service—At Westinghouse Elec. & Mfg. Co. Directed by R. H. Brace, C. R. Austin, G. P. Halliwell. Published A.I.M.E., 1932. A study of a number of iron-nickel-cobalt alloys containing titanium and other elements. These have exceptionally high "proportional limits" and ultimate tensile strength at 600 deg. C.

Hardness of chromium at room and at elevated temperatures—At U. of Michigan. Directed by Prof. A. E. White and R. Schneidewind. Sponsored by U. of Michigan. Completed, 1931. "Trans.," Am. Soc. Steel Treating, 19: 115-140 (1931).

Influence of calorizing on high-temperature properties of carbon steels and ferrous alloys—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by The Calorizing Co. In progress. Creep characteristics of many low-alloy steels are improved by calorizing.

Scaling of steel at elevated temperatures—At U. of Michigan. Directed by Prof. A. E. White, Prof. W. P. Wood, W. E. Jominy and D. W. Murphy. Sponsored by Industrial Gas Research Comm., American Gas Assoc. Completed, 1932. "Trans.," Am. Soc. for Steel Treating, 19: 193-232 (1932).

Investigation of various heat-resisting irons as applied to stoker furnace parts—At Riley Stoker Corp. Sponsored by Riley Stoker Corp. In progress.

High-strength boiler steels—At International Nickel Co. D. & R. Dept. Sponsored by International Nickel Co. In progress.

Endurance properties of some well-known steels in steam—At General Electric Co. A.S.S.T., Boston, Sept., 1931, T. S. Fuller.

Notch effect in fatigue of steel—At Bureau of Standards. Sponsored by Bureau of Standards. In progress. "B. S. Jnl. Research," Vol. 9, p. 9, 1932 (RP454); and "Proc." A.S.T.M., Vol. 32, p. 430, 1932.

Fatigue and corrosion fatigue investigation of ferrous metals for specific application—At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by W. C. Stewart. Sponsored by Bureau of Eng., Navy Dept. In progress. Preliminary articles in various magazines by Dr. D. J. McAdam, Jr., Lieut. H. E. Haven, U.S.N., and W. C. Stewart. Fatigue and corrosion-fatigue limits exist for every ferrous alloy. These must be taken into account in design.

Fatigue of metals—At U. of Illinois. Directed by H. F. Moore. Sponsored by U. of Illinois, A.S.M.E., A.S.T.M. "Proc.," A.S.T.M., 1932. Bulletins Nos. 124, 136, 152, 156, 164, 165, 176, 183, 197, 208, Eng. Exp. Station. Several separate investigations.

Effect of torsion on the fatigue strength of mild steel—At U. of Maine. Directed by W. J. Sweetser. Sponsored by U. of Maine. In progress.

Endurance testing of steel; influence of testing method. Comparison of rotating beam and axial loading method—At Bureau of Standards. Sponsored by Bureau of Standards. In progress. "Proc.," A.S.T.M., Vol. 31, p. 176, 1931.

Development of growth-resistant alloyed cast irons for furnace grates, engine cylinders and other power plant applications — At International Nickel Co. D. & R. Dept. Sponsored by International Nickel Co. Partial report published in "Iron Age," 1933.

Properties of cast iron at high temperature—At Battelle Memorial Inst. Directed by H. W. Gillett. Sponsored by Battelle Memorial Inst. Creep data, etc., published in "Metals & Alloys," Vol. 2, Oct., 1931, p. 229-235. In progress.

Development of a nitridable cast iron containing aluminum—At Mass. Inst. of Tech. Directed by V. O. Homerberg. Sponsored by M.I.T. Dept. of Mining & Metallurgy, Hunt-Spiller Co. In progress.

Growing of cast iron—At Foundry Institute, Aachen. Directed by E. Piwowarski. Sponsored by Aachen Technical College. In progress.

Properties of non-ferrous alloys at elevated temperatures—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by Detroit Edison Co. Completed, 1931. "Trans.," A.S.M.E., 53: 183-191 (1931).

Fatigue and corrosion-fatigue investigation of non-ferrous metals—At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by W. C. Stewart. Sponsored by Bureau of Eng., Navy Dept. In progress.

Development of non-ferrous spring materials for helical coiled springs operating up to 700 deg. F.—At International Nickel Co. Directed by D. & R. Dept. Sponsored by International Nickel Co. In progress.

Non-ferrous alloys of various types for use as valve trim for high-temperature steam—At Brooklyn Edison Co. Sponsored by Brooklyn Edison Co. In progress. May include stainless steels.

Properties of bearing metal alloys (bearing bronzes)—At Bureau of Standards. Sponsored by Bunting Brass & Bronze Co. Completed. "B.S. Jnl. Research," Vol. 8, p. 67, 1932 (RP 401); and Vol. 8, p. 625, 1932 (RP 442).

Effect of addition of lead on hardness of tin-base bearing alloys at elevated temperatures — At Columbia U. Directed by J. N. Kenyon. Sponsored by Columbia U. In progress. To be published, A.S.T.M. "Proc.," 1933.

Bearing-metals — At Foundry Institute, Aachen. Directed by E. Piwowarski. Sponsored by Aachen Technical College. In progress.

Properties of bearing metal alloys (white metal alloys and bearing bronzes)—At Bureau of Standards. Sponsored by War Dept. Completed. "Proc.," A.S.T.M., Vol. 32, Part II, p. 536. Second publication in press.

Tests of wire ropes on machine designed to represent ropeway conditions—At Woolwich Polytechnic, England. Directed by Dr. W. A. Scoble. Sponsored by Inst. of Mech. Eng. In progress; four reports published. Peculiarity of results obtained makes further tests necessary.

Wire rope research — At Bureau of Standards. Directed by H. L. Whittemore. Sponsored by A.S.M.E. In progress.

Refractories service conditions in boiler furnaces — At U. S. Bureau of Mines, Pittsburgh Exp. Sta. Directed by R. A. Sherman. Sponsored by U. S. Bureau of Mines and A.S.M.E. U. S. Bureau of Mines Bulletin 334. Complete.

Boiler furnace refractories—At Battelle Memorial Inst. Directed by H. E. Simpson. Sponsored by Boiler Furnace Refractories Comm., A.S.M.E. Completed, 1932. Published in "Jnl. Am. Ceramic Soc.," Vol. 15, No. 10, Oct., 1932 (two papers). A laboratory method for determining slag resistance of refractories was studied and data secured on a number of common brands of boiler-furnace brick.

Boiler furnace refractories—At U. of Illinois, Dept. Ceramic Eng. Directed by Prof. R. K. Hursh. Sponsored by U. of Illinois, A.S.M.E. Not completed. "Trans.," A.S.M.E., 1931, "Comparative Resistance of Refractories to Coal Ash Slags."

Power house refractories—At Columbus, Ohio, branch of Bureau of Standards. Directed by T. A. Klinefelter. Sponsored by A.S.M.E. In progress. "Mech. Engrg.," Vol. 49, No. 5; 1927. "Trans.," A.S.M.E. Fuels & Steam Power Section; 1931

Use of metal foil as heat insulator—At Battelle Memorial Inst. Directed by J. L. Gregg. Sponsored by Reynolds Metal Co. "Product Engineering," Vol. 3, 1932, p. 204-206; "Refrigerating Engineering," Vol. 23, May, 1932, p. 274-283. Air spaces bounded by bright metal foil are useful in insulation of refrigerators, buildings, hot water heaters, etc.

Heat insulation material—At Battelle Memorial Inst. Directed by F. B. Hobart. Sponsored by Battelle Memorial Inst. Being continued in 1933. A heat insulation structural material is being developed.

Properties and use of Silica-Gel and other adsorption substances—At U. of Michigan. Directed by F. E. Bartell. Sponsored by U. of Michigan.

Wear of metals — At Mech. Technology, Lab., Vienna. Directed by P. Ludwik, R. Scheu, J. Krystof. Sponsored by College of Technology, Vienna. Completed, end of 1932.

Wearing qualities of cylinder wall materials — At U. of Minnesota. Directed by K. G. Jones. Sponsored by U. of Minnesota and Minneapolis-Moline Co. In progress.

Investigation and test of materials to resist wear in pulverized fuel mills—At Riley Stoker Corp. Sponsored by Riley Stoker Corp. In progress.

Methods of determining limits of impurities required for sulphuric acid for battery use — At Bureau of Standards. Sponsored by Bureau of Standards. In progress.

Effect of antimony on rate of sulphation and charging potentials of negative plates of storage batteries—At Bureau of Standards. Sponsored by Bureau of Standards. In progress.

Aging of steel — At Iron Smelting Inst., Berlin. Directed by R. Durrer, G. Schmidt. Sponsored by Berlin Technical College. In progress.

Magnetic properties of steel and their correlation with other properties and with general performance—Sponsored by A.S.T.M., Comm. A-8. "Proc.," A.S.T.M. Vol. 31, part II, p. 94, 1931. Report of Comm A-8, 1931. Investigation to study relation between magnetic properties and toughness as indicated by results of impact test.

Rôle of nickel in nitriding steels—At Mass. Inst. of Tech. Directed by V. O. Homerberg, J. P. Walstead, H. J. French. Sponsored by International Nickel Co. "Trans.," A.S.S.T., Buffalo Meeting, Oct., 1932.

Effect of metallic coatings on steel—At Mech. Tech. Institute, Karlsruhe. Directed by A. Kessner, Koch. Sponsored by Karlsruhe Technical College. Completed, Easter, 1933. Influence of coatings on vibrational stiffness.

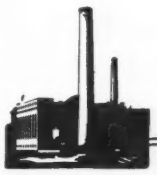
Alloys of iron—At Battelle Memorial Inst. and New York City. Directed by Alloys of Iron Committee, G. B. Waterhouse, chairman. Sponsored by Engineering Foundation, Battelle, many steel and alloy producers. Monograph on Alloys of Iron and Molybdenum, by J. L. Gregg. Seven others in preparation. Critical review and compilation of data. Includes high temperature properties. Five-year program, about half completed.

Temperable lead-nickel cadmium alloys—At Strength of Materials Lab., Danzig. Directed by H. Lorenz, B. Garre, A. Müller. Sponsored by Danzig Technical College. Conclusion expected, 1933. "Zeitschrift f. anorg. allg. Chemie," Vol. 205, p. 42.

Thermo-electric properties of pure metals—At Bureau of Standards. Sponsored by Bureau of Standards. In progress. In press.

Standardization of base metal thermocouple materials—At Bureau of Standards. Sponsored by Hoskins Manufacturing Co. Completed, 1932. Publication later.

Copper embrittlement — At General Electric Co. A.I.M.M.E., Boston, Sept., 1931. L. L. Wyman.



Metering for dust-removal installations—At Experimental Section, Berg-Akademie Freiberg. Directed by K. Kegel, Kohlschein. Sponsored by Berg-Akademie Freiberg. Undergoing test.

Development of an instrument for the quantitative measurement of the amount of solid matter suspended in the atmosphere—At U. of Washington. Directed by E. L. Ohle. In progress.

Methods of estimating and recording dustiness—At Harvard U.

Air pollution—At Mellon Inst. of Ind. Research, U. of Pittsburgh. Directed by H. B. Meller. In progress, all results published.

Smoke abatement—At Mellon Inst. of Ind. Research, U. of Pittsburgh. Directed by L. B. Sisson. In progress; all findings are released for publication.

Electric cleansing of gases—At Electrical Lab., Berg-Akademie Freiberg. Directed by G. Brion, S. Franck, J. Krutzsch, H. Köck. Sponsored by Berg-Akademie Freiberg. In progress. Part 1, "VDI Zeitschrift," Vol. 75, p. 1455.

Cleaning gases with wet filter—At Treating Lab., Aachen. Directed by E. Blümel, L. Honigmann, A. Pelzer. Sponsored by Aachen Technical College. In progress.

Performance tests of dry dust collector—At Riley Stoker Corp. Sponsored by Riley Stoker Co. In progress.

Performance tests of wet dust collector—At Riley Stoker Corp. Sponsored by Riley Stoker Corp. Completed. Has resulted in development of a flue gas scrubber.

Studies to remove sulphur dioxide from the flue gases, to prevent corrosion and atmospheric pollution—At U. of Illinois. Directed by Dr. H. F. Johnstone. Sponsored by U. of Illinois, Utilities Research Comm., Inc. Published "Ind. & Eng. Chem." Two new methods partially developed.

Smoke abatement in the New York metropolitan district — At Brooklyn Polytechnic Inst. Directed by E. F. Church, Jr. In progress.

Smoke conditions in New York metropolitan area—At Stevens Inst. In progress. Work begun in 1930.

Study of the cinder, soot and ash de-

posits in the city of Kalamazoo—Directed by Prof. C. H. Fessenden, U. of Michigan. Sponsored by City of Kalamazoo, Mich. Completed, 1931. Results presented to City of Kalamazoo.

SO_2 in Pittsburgh Air—At Pittsburgh Testing Lab. Directed by C. E. Betz. To be published.

PUMPING

Power pump characteristics when pumping viscous fluids—At U. of Oklahoma. Directed by W. H. Carson. Sponsored by A.S.M.E. (Mid-Continent Sec.) and U. of Oklahoma. Progress report, A.S.M.E. In progress

Preventing cavitation in high-speed centrifugal pumps by prepumping with friction pumps—At Inst. for Hydraulic Research, Berlin. Directed by H. Föttinger, Vogelpohl. Sponsored by Berlin Technical College. In progress.

Cavitation in centrifugal pumps—At Hydraulisches Inst. der Technischen Hochschule, Munchen. Directed by Dr. D. Thoma. Sponsored by Notgemeinschaft der Deutschen, Wissenschaft. In progress.

Behavior of centrifugal pumps under abnormal conditions of flow—At Hydraulisches Inst. der Technischen Hochschule Munchen. Directed by Dr. D. Thoma. Sponsored by Notgemeinschaft der Deutschen Wissenschaft. Preliminary publication in Bulletin No. 4 of "Mitteilungen des Hydraulischen Instituts der Technischen Hochschule Munchen," and in "Power" by C. P. Kittredge.

Effect of radial ribs on end thrust of centrifugal pumps—At U. of California. Directed by Nelson. Sponsored by U. of California. To be completed, 1933. Thesis.

Reversed flow in centrifugal pumps—At U. of California. Directed by M. P. O'Brien. Sponsored by U. of California. Completed. Thesis.

Propeller pump investigations — At Hydrodynamic Machinery Inst., Karlsruhe. Directed by W. Spannhake, E. Meyer. Sponsored by Karlsruhe Technical College. In progress. Mutual influence of the blades.

Rotary pump investigation—At Machinery Lab., Dresden. Directed by R. Mollier, A. Nägel, W. Pauer, Kluge. Sponsored by Dresden Technical College. "Zeitschrift VDI," Vol. 76, p. 609.

Distribution of pressure on moving and guide blades of radial centrifugal pump—At Pump Lab., Braunschweig. Directed by C. Pfleiderer, E. Hagmayer. Sponsored by Braunschweig Technical College.

Occurrences in centrifugal pumps on sudden failure of drive—At Hydraulic Inst., Munich. Directed by D. Thoma, C. P. Kittredge. Sponsored by Munich Technical College. Completed. In press.

Centrifugal reaction pump—At U. of Michigan. Directed by Prof. A. F. Sherzer. Sponsored by U. of Michigan. Projected. Pump uses discharge reaction to reduce power consumption. Rotates in air to reduce frictional losses.

Fundamental characteristics of rotating dry-vacuum pumps—At Detroit Edison Co. Sponsored by Detroit Edison Co. In progress.

Problems of modern pump and turbine design—At Mass. Inst. of Tech. Directed by W. Spannhake. Sponsored by M.I.T. Mech. Eng. Dept. Paper at Annual Meeting of A.S.M.E., Dec., 1932.

Currents in revolving channels of radial centrifugal pumps and turbines—At Aerodynamic Inst., Danzig. Directed by G. Flügel, E. Grünagel. Sponsored by Danzig Technical College. Completed.

Model studies of pumps and turbines by use of rotoscope—At Hydro Machinery Lab., M.I.T. Sponsored by Mass. Inst. of Tech. In progress. Rotoscope constructed by Dr. D. Thoma.

Air-lift and gas-lift—At U. of California. Directed by M. P. O'Brien, J. E. Gosline, Dept. of Petroleum Eng. In progress. Velocity of rise of bubbles as a function of viscosity and surface tension.

STEAM TURBINES

Improvements in the efficiency of reaction blading—At C. A. Parsons & Co., Ltd. Directed by R. Dowson. Sponsored by C. A. Parsons & Co., Ltd. Not completed.

Blade erosion in steam turbines—At Johns Hopkins U. Directed by A. G. Christie. Sponsored by N.E.L.A., Johns Hopkins U. Completed, Turbine report N.E.L.A., 1932.

Erosion testing of turbine blade materials—At Westinghouse Elec. & Mfg. Co. Directed by T. F. Hengstenberg. "Power," Sept. 1932. Accelerated tests reveal erosion-resisting metals.

Erosion of steam turbine blades—At C. A. Parsons & Co. Ltd. Directed by F. W. Gardner. Sponsored by C. A. Parsons & Co., Ltd. "The Engineer," Feb. 5-12-19, 1932.

Governor performance during system disturbances—At General Electric Co. Directed by R. C. Buell, R. J. Caughey and E. M. Hunter of G. E. Co. and V. M. Marquis of American Gas & Electric Co. "Elec. Eng.," Jan., 1931, pp. 37-41.

Mercury-vapor turbines—At General Electric Co. In progress.

Physical properties and behavior of materials now used for turbine blades—At U. of Michigan. Directed by Prof. A. E. White and R. Schneidewind. Sponsored by Detroit Edison Co. Projected. Too early to form definite conclusions.

THERMAL

Steam research—At Mass. Inst. of Tech. Directed by F. G. Keyes, L. B. Smith. Sponsored by M.I.T. Research Lab. of Phys. Chem., A.S.M.E. Special Research Comm. on Thermal Properties of Steam. "Mechanical Eng.," Vol. 53, 54, 55.

Properties of steam—At Imperial College of Technology. Directed by A. Egerton and G. S. Callendar. Sponsored by British Elec. Research Assn. To be published.

Thermal constants of superheated high-pressure steam—At Laboratory of Technological Physics, Munich. Directed by O. Knoblauch, We. Koch. Sponsored by Munich Technical College. "Zeitschrift techn. Physik," Vol. 13, p. 263.

Specific heats of superheated steam—At Laboratory of Technological Physics, Munich. Directed by O. Knoblauch, We. Koch. Sponsored by Munich Technical College. "Forschung," Vol. 3, p. 1. From 120 to 200 atmospheres at various saturation temperatures up to 400 deg. C.

Tables and diagrams for steam computed from specific heat.—At Laboratory of Technological Physics, Munich. Directed by O. Knoblauch, E. Raisch, H. Hausen, We Koch. Sponsored by Munich Technical College. Pub. Munich and Berlin, 1932.

Thermal properties of water and saturated steam at high temperatures—At Bureau of Standards. Sponsored by A.S.M.E. In progress. "B.S. Jnl. Research," Vol. 8, p. 321, 1932 (RP 416). "Mech. Eng.," Vol. 54, p. 118, Feb., 1932. "Trans." A.S.M.E., 1932.

Heat conductivity of (a) water up to 270 deg. C, (b) various liquids — At Machinery Lab., Danzig. Directed by E. Schmidt, W. Sellschopp. Sponsored by Danzig Technical College. (a) "Forschung," Vol. 3, No. 6; (b) in progress.

Saturated ammonia water; (a) pressure, temperature and juncture of liquid vapor phases; (b) volume measurements; (c) heat content—At Machinery Lab., Dresden. Directed by R. Mollier, A. Nägel, W. Pauer, Wucherer, Zinner. Sponsored by Dresden Technical College. (a) "Zeitschrift Kälteindustrie," Vol. 39, p. 97; (b) to be completed 1933; (c) completed 1932.

Behavior of substances of low-boiling point—At Physical-chem. Inst., Breslau. Directed by F. Simon. Sponsored by Breslau Technical College. "Zeitschrift Physic. Chem. and Zeitschr. Physik." Pressures up to 10,000 atmospheres.

Thermal properties of solutions—At U. of Michigan. Directed by Prof. W. L. McCabe. Sponsored by U. of Michigan. In progress. To be published.

High-temperature heating by means of high-boiling-temperature organic vapors

—At U. of Michigan. Directed by W. L. Badger.

Thermal properties of petroleum—At U. of Michigan. Directed by Prof. G. G. Brown. Sponsored by U. of Michigan. In progress.

Thermal conductivity of liquids—At Mass. Inst. of Tech. Directed by O. K. Bates, G. B. Wilkes. Sponsored by M.I.T. Mech Eng. Dept. Thesis. Not published.

Thermal conductivities of materials at high temperatures—At Bureau of Standards. Sponsored by Bureau of Standards. In progress.

Thermal conductivity of refractories—At Mellon Inst. of Ind. Research, U. of Pittsburgh. Directed by R. H. Heilman. Sponsored by A.S.T.M. In progress.

Thermal conductivity of metals—At Bureau of Standards. Sponsored by Bureau of Standards. In progress.

Thermal conductivity of various insulating materials and different combinations of insulating materials in 24-in. hot-plate, and with a 4-in. hot plate—At U. of Toronto. Directed by Prof. Allcut. Publication to be in "Jnl. of A.S.H.V.E."

Effect of humidity and moisture content on thermal conductivity—At Pennsylvania State College. Directed by F. G. Hechler, E. R. Queer. Sponsored by Pennsylvania State College. In progress. A.S.H.V.E. paper.

Heat Insulation—At Mellon Inst. of Ind. Research, U. of Pittsburgh. Directed by R. H. Heilman and R. W. Ortmiller. Sponsored by Philip Carey Co., Lockland, Cincinnati, Ohio. Studies constantly in progress; special attention to high-temperature insulation.

Latent and specific heats of petroleum oils—At Bureau of Standards. Sponsored by Bureau of Standards. In progress.

True specific heat of iron—At Iron Smelting Inst., Aachen. Directed by W. Eilender, Esser and Baerlecken. Sponsored by Aachen Technical College. Completed, 1932.

Coefficient of expansion of weld metal—At Watertown Arsenal. Directed by M. Yatsevitch. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Thermal expansion of iron-carbon alloys—At Iron-Smelting Inst., Aachen. Directed by W. Eilender, Esser and Eusterbrock. Sponsored by Aachen Technical College. Completed, 1932.

Recording gas calorimeters—At Bureau of Standards. Sponsored by Bureau of Standards. Completed. "B. S. Jnl. Research," Vol. 10, p. 99, 1933. (RP 519).

Gas analysis — Volumetric heating value of fuel gas—comparison of observed values with those calculated from analysis. — At Bureau of Standards. Sponsored by Bureau of Standards. "Amer. Gas Jnl.," Vol. 42, p. 135, 1931.

Heats of combustion of pure gases and of volatile liquids—At Bureau of Standards. Sponsored by Bureau of Standards. In progress. Twelve published papers.

Methods of testing heat—At Nat. Research Lab. Directed by C. D. Niven. Sponsored by Nat. Research Council of Canada. "Can. Jnl. Research," Vol. 7, pp. 115-130 (1931).

Study of the absolute temperature scale—At Mass. Inst. of Tech. Directed by D. D. Jacobus, L. J. Gillespie. Sponsored by M.I.T. Mech. Eng. Dept. Thesis. Not published.

WATER POWER

Measuring pressure and speed of Kaplan turbine model—At Hydrodynamic Machinery Inst., Karlsruhe. Directed by W. Spannhake, K. Hahn. Sponsored by Karlsruhe Technical College. Completed.

Tests on bucket turbines—At Hydraulic Machinery Testing Bureau, Darmstadt. Directed by W. Wagenbach, Eilken. Sponsored by Darmstadt Technical College. In progress.

Currents around rotating blades in open tanks—At Hydrodynamic Machinery Inst., Karlsruhe. Directed by W. Spannhake, F. Obenaus. Sponsored by Karlsruhe Technical College. Completed.

Measuring pressure at rotor of Kaplan turbine with and without cavitation—At Machinery Lab., Dresden. Directed by R. Mollier, A. Nägel, W. Pauer, Reinhardt. Sponsored by Dresden Technical College. In progress.

Measuring pressure at blades of Kaplan rotor—At Hydrodynamic Machinery Inst., Karlsruhe. Directed by W. Spannhake, E. Walter. Sponsored by Karlsruhe Technical College. In progress.

Investigation of Peck pressure taps as a means for recording amount of water flowing through turbine wheels—At Worcester Polytechnic Inst. Directed by C. M. Allen. Sponsored by Worcester Polytechnic Inst. These pressure taps after calibration make it possible to install apparatus to indicate and record discharge through a turbine wheel.

Cavitation and its influence on turbine design—At Mass. Inst. of Tech. Directed by W. Spannhake. Sponsored by M.I.T. Mech. Eng. Dept. In progress. Paper No. 222 by Hydraulic Comm. of N.E.L.A., June, 1932. Test unit is complete; endurance tests of various materials have been made. Work to determine effect of air content on cavitation to start.

Cavitation in hydraulic machinery—At Machinery Lab., Dresden. Directed by R. Mollier, A. Nägel, W. Pauer, Reinhardt. Sponsored by Dresden Technical College. Thesis. Application of law of similarity.

Physical conditions and destroying effect of cavitation—At Mass. Inst. of Tech. Directed by W. Spannhake. Sponsored by M.I.T. Mech. Eng. Dept. In progress. Test results are in good agreement with present-day cavitation theory.

Cavitation in models—At Hydrodynamic Machinery Inst., Karlsruhe. Directed by W. Spannhake, O. Hülsenbeck. Sponsored by Karlsruhe Technical College. In progress. Influence of size of model on the beginning of cavitation.

Model studies of the effect of angularity and depth of approach on the discharge over spillways—At River Hydraulic Lab., Mass. Inst. of Tech. Directed by K. C. Reynolds. Sponsored by Mass. Inst. of Tech. In progress. Graduate thesis.

Discharge of water through spillway gates—At River Structures Lab., Karlsruhe. Directed by Th. Rehbock, H. Schwarzmann. Sponsored by Karlsruhe Technical College. Completed. Pressure and velocity; turning moment for various positions.

Most favorable construction of aprons at spillways and dams—At River Works Lab., Karlsruhe. Directed by Th. Rehbock. Sponsored by Karlsruhe Technical College. In progress. Summary of various researches.

Hydraulic model studies of Cle Elum Dam spillway—At U. S. Bureau of Reclamation. Directed by E. W. Lane. Completed. Bureau of Reclamation Tech. Memo. No. 290. Flume with narrower section in the middle developed in which undesirable wave action did not exist.

Model tests for design of Madden Dam spillway—At U. S. Bureau of Reclamation. Directed by R. R. Randolph, Jr. Completed. Determination of best form of protection against scour at toe of dam. Tail water depth greater than that required to form jump on an apron at stream bed level.

Characteristics of syphon spillways—At U. of California. Directed by Saylor and Anderson. Sponsored by U. of California. Completed. Thesis. Comparison of models with prototypes and determination of effect of air leakage on coefficient of discharge.

Experimental study of flow over typical spillway section—At River Hydraulic Lab., Mass. Inst. of Tech. Directed by L. Reid. Sponsored by Mass. Inst. of Tech. In progress, apparatus constructed. Measurements of pressure distribution, nappe profile and discharge will be made for models of various spillway crests in a glass channel 1 ft. wide.

Water flow in penstocks investigated by the salt velocity method—At Worcester Polytechnic Inst. Directed by C. M. Allen. Sponsored by Worcester Polytechnic Inst. In progress.

Under-flow at dams on permeable subsoil—At Hydraulic Institute, Berlin, Directed by A. Ludin, A. Agatz, M. Th. Ahmad. Sponsored by Berlin Technical College. In progress.

Seepage of water through soil in various directions—At Waterworks Inst., Berlin. Directed by A. Ludin, A. Agatz, Th. Oehler. Sponsored by Berlin Technical College. In progress.

Braced earth dams—Stress distribution, suitableness of materials, effect of seepage and overflow—At Earth-work Inst., Aachen. Directed by H. Proetel. Sponsored by Aachen Technical College.

For report to World Power Conference, Stockholm, 1933.

Model studies of Delaware dam, Mongaup River, N. Y.—At Mass. Inst. of Tech. River Hydraulic Lab. Directed by K. C. Reynolds, C. H. MacDougall. Sponsored by Charles T. Main, Inc. Reported to Charles T. Main, Inc., Feb., 1931. Original apron design caused heavy scour against a retaining wall. An apron design was evolved which moved the maximum scour 30 ft. from the wall and reduced the depth of scour to 45 per cent of original design.

Hydraulic model experiments for the design of Hoover Dam—At U. S. Bureau of Reclamation, Research Division. Sponsored by U. S. Bureau of Reclamation. In progress. Most of the experiments made at Hydro. Lab. of the Colorado Ag. College, and the Montrose Lab. of the Bureau of Reclamation.

Distribution of pressure along parallel guide vanes—At Hydrodynamic Machinery Inst., Karlsruhe. Directed by W. Spannhake, K. Schmarje. Sponsored by Karlsruhe Technical College. Completed, Feb., 1933.

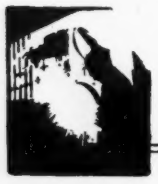
Currents along axial guide-vanes—At Hydraulic Machinery Inst., Hannover. Directed by F. Oesterlen, W. Engel. Sponsored by Hannover Technical College. "Ingenieur-Archiv.," Vol. 3, p. 183.

Thermo-electric determination of efficiency of hydraulic machinery—At Institute for Hydraulic Research, Berlin. Directed by H. Föttinger, Umpfenbach. Sponsored by Berlin Technical College. About to be completed. Efficiency of turbines and centrifugal pumps.

Formation of anchor and frazil ice in streams and canals—At Hydraulic Inst., Berlin. Directed by A. Ludin, A. Agatz. Sponsored by Berlin Technical College. In progress.

Hydrodynamic research—At National Research Lab. Directed by J. H. Parkin. Sponsored by Nat'l. Research Council of Canada. Laboratory established, work begun.

Water Jet pump—At U. of California. Directed by M. P. O'Brien, J. E. Gosline. Sponsored by U. of California, Dept. of Mech. Eng. Pacific Coast Applied Mechanics Meeting, Jan. 20, 1933.



WELDING

Influence of weld rod on properties of weld—At Westinghouse Elec. & Mfg. Co. Directed by F. R. Hensel, E. I. Larsen. A.S.S.T. "Trans.," May, 1932, pp. 639-672. "Jnl. Amer. Weld. Soc.," April, 1932. "Metals & Alloys," 1932. Quantitative information on the metallurgy of arc welds as related to composition, physical properties, aging phenomena and resistance to corrosion as affected by the nature of the welding rod, fluxes, atmosphere, etc.

Effect of coating on rods when welding with D.C. and A.C.—At Welding Lab., Hannover. Directed by P. Bardtke, Rauschenfels. Sponsored by College of Technology, Hannover. Completed.

Influence of magnetism on the welding arc—At General Electric Co. "Welding," June, 1931, R. M. Stephens.

Nitride needles as affecting age-hardening properties—At Lehigh U., Dept. of Phy. Metal. Directed by Gilbert Doan. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Effect of nitrogen in arc-weld metal—At Mass. Inst. of Tech. Directed by R. S. Williams. Sponsored by Engineering Foundation Research Comm., Am. Bureau of Welding. In progress.

Effect of oxygen on the distribution of pearlite in weld metal—At Mass. Inst. of Tech. Directed by H. R. Bullock. Sponsored by M.I.T. Mech. Eng. Dept. In progress. In cooperation with Fundamental Research Comm., American Bur. of Welding.

Effect of peening upon the quality of electric welds—At Ohio Northern U. Directed by John A. Needy. Sponsored by Ohio Northern U., Bureau of Welding, Nat. Research Council. In progress.

Improving welds by peening—At U. of Tennessee. Directed by W. R. Woolrich. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Factors influencing the welding quality of steel—At Case School of App. Science. Directed by H. M. Boylston. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Metal transfer during arc welding—At Lehigh U., Dept. of Phy. Metal. Directed by Gilbert Doan. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Metal deposition in electric arc welding—At General Electric Co. Directed by J. M. Weed, G.E. Co., and G. E. Doan, Lehigh U. "Elec. Engineering," Dec. 1932, pp. 852-854. Experimental work indicates that liquid globules are the chief form of metal transfer in electric arc welding. A new method of high-speed "recording" produces a metal record which can be compared directly with a corresponding oscillogram.

Conditions in carbon and metallic arcs—At Department of Welding Technology, Berlin. Directed by A. Hilpert, H. v. Conrady, G. Müller. Sponsored by College of Tech., Berlin. Completed.

Metallographic study of arc welds—At Dept. of Welding Technology, Berlin. Directed by A. Hilpert, Hanemann. Sponsored by College of Technology, Berlin. "Elektroschweissung," Vol. 3.

Weldability of cast iron—At Penn. State College. Directed by P. R. Hall. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Welding of malleable nickel and Monel metal tubing and plate—At International Nickel Co. Directed by D. & R. Dept. Sponsored by International Nickel Co. In progress. Partial reports have appeared in "Jnl. Am. Welding Soc."

Fatigue properties of welds—At General Electric Co. "Jnl. Amer. Weld. Soc.," Oct., 1931, R. A. Weinman. Effect of addition of metals in steel as filler rod and base metal.

Fatigue of welds—At Mass. Inst. of Tech. Directed by J. H. Zimmerman. Sponsored by M.I.T. Mech. Eng. Dept. In progress. In cooperation with Fundamental Research Comm., American Bur. of Welding.

Corrosive fatigue testing—At Lehigh U., Dept. Metal Eng. Directed by W. A. Harvey. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Creep of welds, effects, distribution and methods of adjusting internal stresses due to welding—At Schenectady Lab., G. E. Co. Directed by R. A. Weinman. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Influence of welding on creep characteristics of ferrous metals—At U. of Michigan. Directed by Prof. A. E. White and C. L. Clark. Sponsored by Detroit Edison Co. In progress; date of probable completion, 1934. Creep characteristics are influenced both by welding and by type of weld.

Mechanical properties of weld metal at various temperatures by short-time tensile tests, impact, bend, embrittlement, creep and repetition tests—At U. of Sheffield, Brown Firth Lab. and Royal Naval College. Directed by Prof. F. C. Lea. Sponsored by Inst. of Mech. Eng. In progress.

Impact strength of welds—At Mass. Inst. of Tech. Directed by J. H. Zimmerman. Sponsored by M.I.T. Mech. Eng. Dept. In progress. In cooperation with Fundamental Research Comm., American Bur. of Welding.

Strength of welded containers under varying internal pressure—At Materials Testing Bureau, Stuttgart. Directed by E. Siebel, Ulrich. Sponsored by College of Technology, Stuttgart. In progress.

Permanance of welded and cast construction—At Materials Testing Bureau, Darmstadt. Directed by A. Thum and Ruttmann. Sponsored by Darmstadt Technical College. In progress.

Durability of acetylene-welded boiler plates—At Institute of Mechanical Technology, Karlsruhe. Directed by A. Kessner, Pester. Sponsored by College of Technology, Karlsruhe. "Zeitschrift fur Schmelzschweiss," 1932, No. 6.

Durability of welded joints—At Institute for Power Engineering, Braunschweig. Directed by F. Meyenberg; Baumgärtel. Sponsored by Braunschweig Technical College. In progress.

Durability of welded joints under impact tests—At Machinery Lab., IV, Darmstadt. Directed by L. V. Roessler. Sponsored by College of Technology, Darmstadt. Completed, 1932.

Shear stresses in welds—At U. of Pittsburgh. Directed by R. F. Edgar. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Initial strains and residual stresses resulting from heating incident to welding—At Columbia U. Directed by W. J. Krefeld. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Quantitative studies of stresses caused by welding—At Rensselaer Polytech.

Inst. Directed by T. R. Lawson. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Strains caused by welding patches into plates—At Welding Lab., Danzig. Directed by H. Behrens, H. Duchmann. Sponsored by College of Technology, Danzig. In progress.

Strains due to welding—At Institute of Mechanical Technology, Karlsruhe. Directed by A. Kessner, Kleiner. Sponsored by Karlsruhe Technical College. Completed, 1933.

Shrinkage and shrinkage strains—At Welding Lab., Hannover. Directed by P. Bardtke, Koch. Sponsored by College of Technology, Hannover. In progress.

Distribution and magnitude of strains due to welding—At Machinery Lab. IV, College of Technology, Darmstadt. Directed by L. V. Roessler. Sponsored by College of Technology, Darmstadt. In progress.

Strains in welded joints—At Materials Lab., College of Technology, Aachen. Directed by F. Rötscher, Quadflieg. Sponsored by College of Technology, Aachen. In progress. Measurement of strains.

Strains in welded seams—At Engineering Lab., College of Technology, Darmstadt. Directed by H. Kayser. Sponsored by College of Technology, Darmstadt. In progress.

Effects of annealing upon the relieving of strain after welding—At Ohio State U. Directed by D. J. Demorest. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Effect of annealing on locked-up stresses in welded specimens—At Rensselaer Polytech. Inst. Directed by T. R. Lawson. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Stresses in welded connections by photo-elasticity—At Columbia U. Directed by A. Solakian and A. H. Beyer. Sponsored by Peters Research Fund. In progress.

New methods of testing welds—At U. of Michigan. Directed by Prof. A. E. White and W. O. Freyberg. Sponsored by Detroit Edison Co. In progress. The "Stray Flux Weld Test Meter Method" for testing welds has been developed. Meters for the shop and field testing of welds have been built and are in use for experimental purposes.

Investigation of welding electrodes and non-destructive weld test method—At U. S. Naval Eng. Exp. Station, Annapolis, Md. Directed by B. Ronay. Sponsored by Bureau of Eng., Navy Dept. In progress.

Use of gamma rays for weld examination—At Lehigh U., Dept. Phy. Metal. Directed by Gilbert Doan. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Non-destructive tests for welds by magnetic methods, X-ray and radium ray—At Ohio State U. Directed by D. J. Demorest. Sponsored by Am. Bureau of Welding, Nat. Research Council.

X-ray diffraction method for investigating stresses in welds—At Mass. Inst. of Tech. Directed by J. T. Norton. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Testing welds with gamma rays—At Thomson Research Lab., G. E. Co. Directed by P. Alexander. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Tests of welded pipe joints—At U. of Maine. Directed by W. J. Sweetser. Sponsored by U. of Maine. In progress.

Volt-amp. characteristics of pure iron arc—At Lehigh U., Dept. Phys. Metal. Directed by Gilbert Doan. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Use of polyphase current for welding ferrous and non-ferrous metals—At Welding Lab., Hannover. Directed by P. Bardtke, Könnecker. Sponsored by College of Technology, Hannover. Completed, 1932.

Quality and economics of atomic and autogenous welding—At Institute for the Science of Management, Braunschweig. Directed by F. Meyenberg, Brück. Sponsored by College of Technology, Braunschweig. In progress.

Studies on the deformation of welded test-pieces—At Inst. for Mechanical Technology, Karlsruhe. Directed by A. Kessner, Zaeringer. Sponsored by College of Technology, Karlsruhe. Completed, 1933.

Metallurgical investigation on welds—At Case School of App. Science. Directed by H. M. Boylston. Sponsored by Am. Bureau of Welding, Nat. Research Council.

Effect of temperature and time of annealing on the resistance of welded deposits to wear—At Welding Lab., Danzig. Directed by H. Behrens, O. Müller. Sponsored by College of Technology, Danzig. Completed, 1932.

Tests of condenser tubes of various materials—At Navy Eng. Exp. Sta., Annapolis, Md. Sponsored by U. S. Navy.

Cleanliness factor of condenser tubes—At Brooklyn Edison Co. Sponsored by New York Edison System. In progress. Paper, A.S.M.E. Metropolitan Section, abst. "Power," March, 1933. To determine proper number of tubes to represent condenser average condition.

Average cleanliness factor of commercially chlorinated condenser tubes—At Brooklyn Edison Co. Sponsored by Brooklyn Edison Co. Completed. Under conditions tested chlorination maintained cleanliness factor of 90 to 95. More effective with new tubes.

Heat transmission in steam condenser tubes—At Manchester U. Directed by R. M. Ferguson and J. C. Oakden. Sponsored by British Elec. Research Assn.

Causes of failure in chrome-tungsten steam-pipe bolts—At U. of Michigan. Directed by Prof. A. E. White, C. L. Clark and R. Schneidewind. Sponsored by Electric Bond & Share Co. In progress; to be completed, 1933. Non-uniform material contributing cause to bolt failure. Gives recommended physical properties for suitable bolt stock.

Long-time tests on pipe-flange bolts—At U. of Michigan. Directed by Prof. A. E. White and Prof. W. P. Wood. Sponsored by Detroit Edison Co. In progress; date of probable completion, 1940. The effect of 8 years of service is nil as far as metallographic or metallurgical examination could determine (3½ Ni, 0.90 Chrome, 0.40 C at 600 deg. F.)

Solution cycles for power generation—At U. of Michigan. Directed by W. H. Sellew and Prof. W. L. McCabe. Sponsored by U. of Michigan. In progress. These cycles are high-temperature, low-pressure cycles for the economic conversion of heat into work.

Correlation of the factors determining the optimum steam pressures of industrial power generation—At Columbia U. Directed by W. A. Shoudy. Sponsored by Columbia U. In progress.

Pressure distribution on round vertical cylinders with end plate as used on Madaras Rotor Power Plant—At U. of Minnesota. Directed by J. D. Akerman. Sponsored by U. of Minnesota. In progress.

Research on a new prime mover of the rotor type for using windpower—At Inst. for Hydraulic Research, Berlin. Directed by H. Föttinger, Hoffmann. Sponsored by Berlin Technical College. In progress.

Compression effect in steam nozzles—At Johns Hopkins U. Directed by A. G. Christie. Sponsored by John Hopkins U. In progress. Investigation of a new method of storing heat during low demand hours to be used at the time of peak demand. It will also throw new light upon the efficiency of steam turbines.

Determination of moisture in steam by means of a beam of light—At Calif. Inst. of Tech. Directed by C. C. Thomas. In progress. "Trans.," A.S.M.E., 1932.

Effect of inlet boxes on the performance of centrifugal fans—At Gordon McKay Lab., Harvard Eng. School. Directed by Prof. Marks & Mr. Winzenburger. Sponsored by Prof. Marks. Completed, 1931. A.S.M.E. "Trans.," 1931. An optimum form of inlet box was found and the loss of capacity and efficiency for a variety of other forms was determined.

Analysis of the action of axial-flow fans—At Gordon McKay Lab., Harvard Eng. School. Directed by Prof. Marks and Mr. Weske. Sponsored by Prof. Marks. In progress. The object is to obtain fundamental data for more accurate theoretical basis for a design of such fans.

Performance of propeller fans of various designs—At Dept. of Mech. Eng., Ohio State U. Directed by Prof. A. I.

Brown. Sponsored by Ohio State U. Eng. Exp. Station. Completed. Bulletin to be published. Performance of propeller fans can be analyzed and recorded in the same manner that is commonly applied to the performance of centrifugal fans with equally consistent results. Power requirement remains nearly constant for all capacities, or being least at the highest pressures.

Effect of elbows and bends in inlet ducts on the performance of centrifugal fans—At Gordon McKay Lab., Harvard Eng. School. Directed by Prof. Marks and Messrs. Lomax and Ashton. Sponsored by Prof. Marks. Completed, 1932. A.S.M.E. "Trans.," 1932. Magnitude of the losses for long-bend and square elbows were determined and it was found possible to reduce these losses to a negligible amount by the insertion of appropriate guide vanes in the bend.

Effect of guide vanes of different shapes when placed within a square-corner sheet-metal elbow where air flow was maintained at velocities ranging from 1,500 to 3,000 ft. per min.—At Dept. of Mech. Eng., Ohio State U. Directed by A. I. Brown. Sponsored by Ohio State U. Eng. Exp. Station. Completed. Eng. Exp. Station "News," Ohio State U., April, 1932. An elbow with square corners without vanes offers a resistance equal to 103 per cent of the velocity pressure, or 7⅛ times that of an elbow with a throat radius equal to the dimension of a side of the duct. The same square-corner elbow when equipped with five vanes of sheet metal 3.9 in. wide, curved to a radius of 2¾ in., offered a resistance of 35 per cent of the velocity pressure.

Ice manufacture at low brine temperatures, and water treatment for ice manufacture—At U. of Illinois. Directed by Dr. Dana Burks. Sponsored by U. of Illinois, Utilities Research Comm., Inc. Completed. To be published in two bulletins, Eng. Exp. Station, U. of Illinois. Any water from a natural source can now be used. Cost of ice production reduced. Plant capacity increased.

Vapor pressure of carbon dioxide—At Bureau of Standards. Sponsored by Bureau of Standards. Completed. In press.

Physiological and pathological action of refrigerants—At U. S. Bureau of Mines, Pittsburgh Exp. Sta. Directed by W. P. Yant. Sponsored by U. S. Bureau of Mines, U. S. Public Health Service and the Frigidaire Corp. U. S. Bureau of Mines Report of Investigation 3013 (1931), 3185 (1932); U. S. Public Health Service paper "Toxicity of Organic Fluorides."

Measurement of machinery noise—At General Electric Co. "Elec. Eng.," May, 1931, pp. 349-351, H. B. Marvin.

Measurement of noises of certain reduction gears used in central stations—At U. of Michigan. Directed by Prof. F. A. Firestone and E. J. Abbott. Sponsored by Detroit Edison Co. Completed. "Power," Vol. 75: 537 (1932). "Jnl. Acoustical Soc.," 3: 455 (1932).

Noise measuring methods—At Westinghouse Elec. & Mfg. Co. Directed by W. O. Osborn, K. A. Oplinger. Sponsored by Acoustical Soc. of Amer. Presented Nov. 29, 1932. This includes the development of a meter which reads noise values in dynes or decibles. There is also an attachment for vibration measurements.

Elastic supports for rotating machinery—At General Electric Co. "Elec. Eng.," May, 1931, pp. 347-349, E. H. Hull and W. C. Stewart. Deals with elastic supports for isolating machines having definite objectionable frequency giving a general theory to apply to single phase motors, motor generator sets, etc.

Vibrations of foundations—At Machinery Lab., Danzig. Directed by E. Schmidt, J. S. Dieckmann. Sponsored by Danzig Technical College. In progress.

Portable instrument for amplifying, analyzing and recording mechanical vibrations—At U. of Minnesota. Directed by J. J. Ryan. Sponsored by U. of Minnesota. Completed, 1933. Instrument has been designed, constructed, and tested. It has been named an Oscillo-Vibrograph. It is inexpensive, accurate and practical.

Vibrations in piping—At Internal-Combustion Engine Lab., Stuttgart. Directed by W. Maier, O. Lutz. Sponsored by Stuttgart Technical College. In progress.

Stress distribution in perforated plate—At Munich Lab. Mech. Technology. Directed by L. Föppl, Y. Nakagawa. Sponsored by Munich Technical College. Completed; not yet published.

Stresses in perforated plate—At Material Testing Bureau, Stuttgart. Directed by E. Siebel. Sponsored by Technical College, Stuttgart. In progress.

Stresses due to heat flow in various machine parts—At Penn. State College Eng. Lab. and U. of Michigan. Directed by Dr. C. H. Kent. Sponsored by Pennsylvania State College, Dept. of Mech. Eng. and U. of Michigan. In progress. A.S.M.E. "Trans.," A.P.M. 53-16, 1931 and A.P.M. 54-18, 1932. Thermal stresses often exceed those produced by pressure or other external forces. Where the part is subjected to high temperatures at the same time, creep may reduce thermal stresses, in time, to zero.

Fundamental studies and research on worm-gear drives—At Mass. Inst. of Tech. Directed by E. Buckingham. Sponsored by A.S.M.E., Am. Gear Mfg. Assoc. In progress. Four progress reports by A.S.M.E. Research Comm. on worm gears. Mathematical analysis of contact conditions and critical study of test results.

Performance and load-carrying capacity of gears—At Mass. Inst. of Tech. Directed by E. Buckingham. Sponsored by Am. Soc. of Mech. Eng., Am. Gear Mfr. Assoc. In progress. "Dynamic Loads on Gear Teeth," A.S.M.E. Research Pub., 1931.

Pipe joint construction for use with 1,000 deg. F. steam—At Detroit Edison Co. Sponsored by Detroit Edison Co. In progress.

Accelerated test for comparing performance and accuracy of pressure gages—At Detroit Edison Co. Sponsored by Detroit Edison Co. In progress.

Commercial uses for electrically precipitated ash from pulverized fuel-fired furnace—At Detroit Edison Co. Sponsored by Detroit Edison Co. In progress. Uses as fillers, admixtures and in manufacture of artificial stone investigated.

Accurate measurement of high-temperature gases—At Mason Lab., Yale U. Directed by Harwood F. Mullikin. Sponsored by Superheater Co., W. J. Wohlenberg. Completed, June, 1932. Thesis.

Accurate electrical measurement of slowly changing temperatures—At Machinery Lab., Karlsruhe. Directed by R. Plank, Barth. Sponsored by Karlsruhe Technical College. Nearing completion.

Development of a fine-wire thermocouple as a wet bulb—At Mass. Inst. of Tech. Directed by J. Holt. Sponsored by M.I.T. Mech. Eng. Dept. In progress.

Platinum resistance thermometry at high temperatures—At Bureau of Standards. Sponsored by Bureau of Standards. In progress.

Measurement of metal temperatures on heat-receiving side of heat exchanging apparatus—Sponsored by Superheater Co. Directed by Arthur Williams. Completed. A.S.M.E. annual meeting paper, 1932. Accuracy of various methods of measurement determined.

Measurement of brief pressures (impulses)—At Machinery Lab., Aachen. Directed by P. Langer, Thomé and Marquard. Sponsored by Technical College, Aachen. Completed, 1932.

X-ray examination of steel valve castings for 1,300-lb. central station service—At U. of Michigan. Directed by Prof. A. E. White and Prof. L. Thomassen. Sponsored by Phoenix Utility Co. Completed, 1931. Development of higher voltage X-ray expands its use for nondestructive examination of heavy-duty steel castings.

Development of an inspection device for surface flaws—At U. of Michigan. Directed by Prof. F. A. Firestone. Sponsored by Timken Roller Bearing Co. Completed, 1932. "Mech. Eng." (1932), "Metal Progress," 21: (No. 4), 57-59 (1932).

Viscosity and its measurement—At Lab. for Treating Materials, Breslau. Directed by W. Gross, H. Zimmer. Sponsored by Technical College, Breslau. "Allg. Oestr. Chem. Tech. Zeitschrift," Vol. 7, p. 48.

Oscillographic recording of torque—At Electrical Machinery Lab., Hannover Directed by K. Humburg, E. Rolf. Sponsored by Hannover Technical College. Completed, July, 1932.

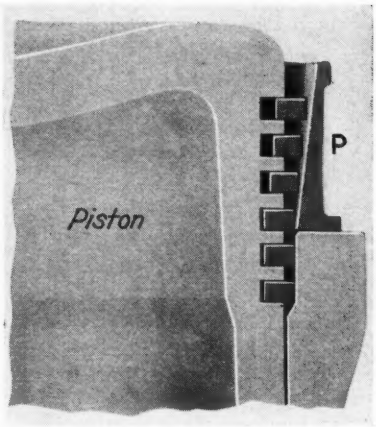
Reliability of valves to close in emergency conditions—At Brooklyn Edison Co. Sponsored by New York Edison System. In progress. Characteristics of motor valve generation.

Oscillation of rotors—At Lab. for Combustion Engines, Graz. Directed by W. Heyn, A. Pischinzer. Sponsored by Graz Technical College. In progress.

Tests on elevator safeties—At Bureau of Standards. A.S.M.E. research fellowship. In progress. M. H. Christopherson, chairman, A.S.M.E. Comm.

POWER'S RESEARCH TABLE

PRACTICAL AIDS TO OPERATION



Engine-Piston Installation Simplified

EVERY diesel and gas-engine operator has experienced the difficulty involved in inserting the piston into the cylinder. It is easy to foul the piston rings or even break them when installing the piston. Various methods are employed to compress the ring sufficiently. The method shown makes putting the piston into the cylinder an easy job.

A ring pot *P*, or metal band, is cast or rolled from heavy plate steel and given a bevel of about 3 in. per ft. on the inside. It should be 7 or 8 in. high for engines with pistons up to 14 in. in diameter. If a casting is used, the pot should be made to fit between the cylinder head studs and the counter bore, and may be provided with a flange at the bottom, as shown, and drilled to center fast against the bolts for rigid support.

When the rings are properly oiled, as they usually are for entering, they slip into the cylinder readily. Rings which must be registered with dowels or multiple-piece rings require only to be properly placed in order to work in the same manner as plain snap rings.

This device can be made up in any local foundry, or plate shop, and the cost is moderate. A plant should have one for each size cylinder, and if so equipped the installation of piston rings will be an easy job. I have had a number of these pots made and the operators using them report favorably on them. They should not be made too heavy, either in casting or plate and should be provided with eye bolts for lifting with chain hoist, since for a large engine, these pots are quite heavy to handle.

Dallas, Texas ORVILLE ADAMS.

Welded Pipe Tested for Restricted Cross-Section

HERE is a wrinkle in testing small-diameter welded pipe for restriction of area that is extremely simple and rapid. On a recent installation of $\frac{1}{2}$-in. and $\frac{3}{4}$-in. pipe coils made up of series of S-bends to carry hot water it was necessary that the bore of the pipe be uniform throughout. The coils were fabricated by a pipe-bending shop and, following the specified hydrostatic tests, were shipped to the job in sections to be butt-welded together to form the required units. The shop fabricated the units in sections of a size practical for shipment. Each section was formed of several lengths of extra-heavy black steel pipe joined with butt welds. The shop men were instructed to exercise great care in making the welds so that the inner portion of each weld would not reduce the inside cross-section of the pipe.

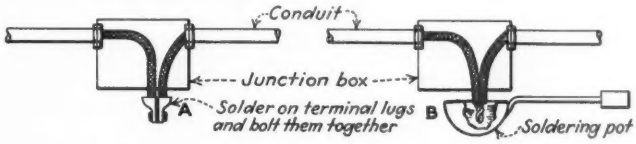
The field erector was a skeptical soul. When the coil sections arrived he bought an assortment of steel marbles from a local five- and ten-cent store. By trial a marble was found which would just pass through the normal bore of the pipe. This marble was inserted in one end of a pipe coil section, an air hose was coupled to that end, and the compressed air turned on, which literally shot the marble through the coil. If the marble passed through the coil and came out the other end the section was accepted.

This test was the means of finding restrictions in several coil sections. These were rejected and returned to the pipe bending shop to have the defects remedied. After the field welding of the sections had been finished a marble was shot through each complete unit in the same manner prior to the customary hydrostatic testing.

Arlington, Mass. THERON W. BEAN.

Conductors Spliced Without Injuring the Insulation

WHEN feeders are run in conduit, unless they are fairly short, it may be necessary to install junction boxes in the line and to splice the conductors in these boxes. When this is done the splices are a potential source of trouble because of the difficulty of making splices in a junction box without injuring the insulation. I have seen a good many grounds and burnouts occur in junction boxes



on both new and old installations. A failure in a junction box may damage the conductor's insulation back into the conduit and make the fault difficult to repair.

The usual procedure of making splices in power wiring is to peel off the insulation and clean the wire for a sufficient length to make the splice. After making the splice, the workman usually uses a blowtorch for soldering the joint, which is heated by playing the flame directly on the splice. This heats the wire for a considerable distance back into the conduit and is likely to damage the insulation. Most wiring failures in junction boxes can be traced to this cause. To overcome these objections and to procure a more reliable splice, I have used for several years two methods of making splices, and have never had an insulation failure in a junction box where these splices were used.

On large conductors the splice is made by soldering on terminal lugs and bolting them together, as at *A* in the figure. Lock washers are placed under the nuts on the bolts to keep them from working loose. *B* shows how splices are made in small wiring by twisting the ends together. The splices are soldered by raising a ladle of molten solder until the end of the splice dips into it, and then lowering the ladle. In most cases a thick coat of solder will stick to the splice, which will indicate that the splice is not hot enough. The pot is again raised and lowered until the solder runs freely off the splice, leaving a fine coating with no lumps or burs.

Splice *A* is easily made without damaging the insulation. It is also convenient in case a section of conduit has to be removed, as the connections can be unbolted without having to untwist the wires. When trouble develops it can be quickly located by unbolting the splices to break the circuit into sections, thus permitting each section to be tested separately.

Tarentum, Pa. MARIN PHILLIPS.

Heat From Lamp Causes Fuses to Blow Out

BULLSEYE type switch boxes were used in connection with the magnetic tables of unit coal pulverizers in a boiler room. Several months after this plant had been in service the cartridge fuses in series with the blades of the double-pole knife switch in this box blew out. The fireman replaced the fuses, and after several hours they again blew out. The station electrician, after examining the switch box and testing the magnetic circuit, could find no evidence of a short circuit, ground or overload. He then questioned the fireman as to any changes made in the equipment. The fireman recalled that he had put in a new bulb in the box behind the red glass bullseye a short time before, as the old one had burned out. It was found that a 75-watt lamp had been put in the socket instead of the customary 25-watt size. The additional heat radiated by the 75-watt bulb was sufficient to cause fuse temperature to rise to the overload condition with but normal current of the magnetic coils passing through them.

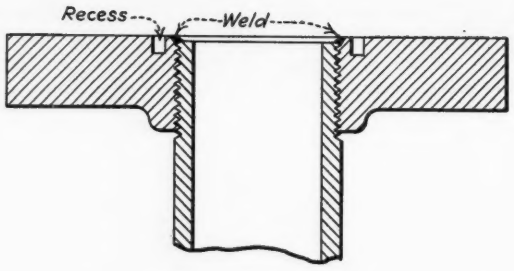
HARRY M. SPRING.

Milford, N. J.

Flanged Pipe Joints Welded to Prevent Leaks

THE DRAWING shows a type of welded joint that I have used successfully on steam and water pipes to prevent leaks at the threads. A groove $\frac{3}{16}$-in. deep by about the same width is cut into the face of the flange before it is placed on the pipe. A metal thickness is left between the groove and the thread about equal to the thickness of the metal in the pipe. The pipe is screwed into the flange until its end lacks about $\frac{1}{8}$-in. of being flush and then the pipe is welded to the flange as shown.

Allowing the end of the pipe to remain back about $\frac{1}{8}$ in. from the face of the flange permits the welding to be done without scoring the face of the flange in a way that would interfere with making a tight joint. The



groove is cut into the face of the flange to relieve the stresses that might be created by welding if the face of the flange were solid for its full width. The joint is made up in the usual way with flat packing, or a metal or a rubber filler may be used in the groove to increase the pressure around this part of the flange.

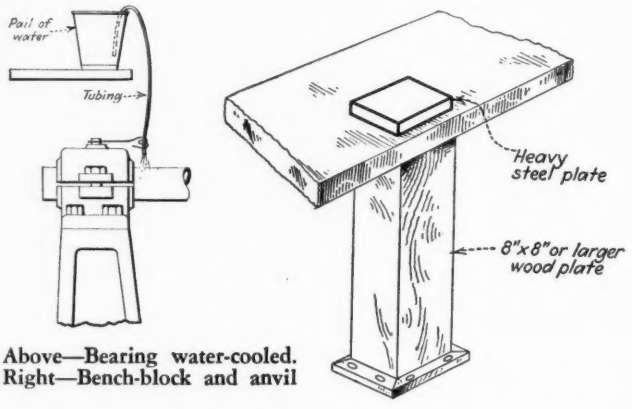
Michel, B. C. D. J. TAYLOR.

Bearing Cooled With Water

THE usual emergency treatment of a hot bearing until the cause can be removed is to let a small stream of cold water run on the shaft near the bearing. This is sometimes not easy to arrange, with the usual pieces of heavier hose. A practical and handy device for directing the water on the shaft is a length of automobile pneumatic-windshield-wiper tubing, a 7- or 8-ft. piece of which can be obtained in a ten-cent store.

The tubing is small but tough and can be held easily in position by a small wire bent and fastened to the bearing, as in the figure. In my case a bucket of water was placed above the shaft and the tubing used to siphon the water onto the shaft.

Missouri Valley, Ia. FRANK W. BENTLEY, JR.



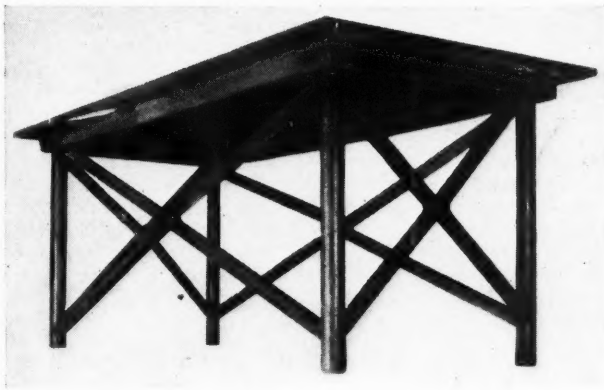
Above—Bearing water-cooled. Right—Bench-block and anvil

Use a Bench Block, Not the Vise, for an Anvil

SOME mechanics and engineers submit a bench vise to severe treatment by using it for an anvil, just because it is handy. The sketch shows a bench block that will be found well worth the making and using to replace the vise for this service. At the bench, a wood post 8 by 8 in. is used to support the block, which is heavy steel plate set into the bench top. It is best to locate the block near the bench vise, thus saving the latter from abuse.

Penacook, N. H. CHAS. H. WILLEY.

CURRENT COMMENT



Heavy Work Bench Made of Welded Pipe

I WAS interested in the article by C. O. Matthews (*Power,* Feb., page 36) giving directions for making a work-bench from pipe and pipe fittings. About ten years ago a bench similar to the one made by Mr. Matthews was needed in our plant, and was constructed as shown in the photo. This bench was built by oxy-acetylene welding, thus doing away with about 20 fittings and 44 threaded pipe ends. Of course, all plants do not have welding and cutting equipment available to do the job shown in our photograph. It may, however, be of interest to those so equipped.

As this bench was designed to carry loads up to 1,000 lb., braces were added in the end panels and a cast-iron top was used. The layout is simple, the legs being made of single lengths of pipe and the braces butt-welded near the top and bottom of each leg. One half of each brace was made from a single length of pipe and the other half from two pieces butt-welded at the center crossing. The general dimensions of the table are: length 52 in., width 22 in., and height 24 in. The four legs are made of 1½-in. pipe and the braces of 1¼-in. pipe. The only tools required, in addition to those for measuring, were cutting and welding blowpipes and a hammer and chisel.

R. L. WAGNER,
Union Carbide & Carbon Research Laboratories, Inc.
Long Island City.

Enthalpy

IN *Power* for March, 1933 (page 134), Prof. J. H. Pound discusses the origin and significance of the name "enthalpy" for the quantity that we have long known under the names "total-heat" or "heat-content." He remarks that the new name was not heard of until five or six years ago, and expresses doubt as to who introduced it. Prof. J. E. Trevor, of Cornell University, who introduced me to the term *enthalpy* about twenty years ago, tells me that, so far as he knows, it was invented and first used by Prof. Kammerlingh Onnes, of the University of Leyden. Papers published in 1909 use the name, ascribing it to Onnes, who presumably proposed its use some time before 1909.

Regnault employed a concept which was long called the *total-heat* or *heat-content,* defined in terms of heat added. This quantity was replaced by the new, slightly different, and much more widely useful quantity introduced by Gibbs, (with the name *heat function for constant pressure),* $u + \frac{144}{778} p v$. The old names were carried over to designate the new idea, despite their inappropriateness, which Professor Pound points out. They imply that the quantity is essentially a heat quantity, which it most emphatically is not. A body can be carried from any low value of enthalpy to any desired high value without ever having any heat transfers to the body—only work transfers. The name *enthalpy* is accordingly to be preferred, because a name based upon an unfamiliar language suggests no meaning; in particular it suggests no false meanings.

Etymologically, the word is derived from the Greek *en* (= in) and *thalpo* (= to warm or to heat), and literally means heat-content, but that is beside the point. We do not attempt to use technical terms in the strictly literal sense of the words from which they are derived. We do, however, find it convenient to avoid combinations of words that appear to suggest obvious meanings that are not correct.

Professor Pound, in speaking of the enthalpy of water at pressures above its vapor pressure for the prevailing temperature, says that it is debatable whether this is subcooled water or super-pressure water. It seems to me that these terms are identical. Water that is at a temperature less than its boiling point for the prevailing pressure is also sustaining a pressure greater than its vapor pressure for the prevailing temperature. It is both subcooled and "superpressured," that is, compressed. Since the terms *subcooled* or *supercooled* are widely used for water that is cooled below the freezing point, it seems advisable to use the term *compressed liquid* for the liquid phase that is displaced from the saturation curve by cooling and/or compression. This situation is well discussed by Prof. J. H. Keenan (*Mechanical Engineering,* Feb., 1931, page 127).

Cambridge, Mass. C. HAROLD BERRY
Professor of Mechanical Engineering
The Harvard Engineering School

Ryburg-Schwoerstadt Turbines

IN THE table of outstanding propeller-type turbines, published in the January number of *Power,* three different ratings are given for the Ryburg-Schwoerstadt units, when they all have the same rating. By request of the customer, all four turbines were designed jointly by the three manufacturing companies mentioned in the table and are alike in rating and dimensions, the runners being 276 in. in diameter. Each unit is designed to develop 44,000-hp. at full gate and 37.7 ft., head. Because these turbines had to be set comparatively low to avoid the danger of serious cavitation, it was decided to limit their output to 38,200 hp. at 37.7-ft. head.

K. J. VAN ERP,
New York City. *J. M. Voith Co., Inc.*

READERS' PROBLEMS

CONDITIONS AFFECTING POWER FACTOR—*I have read E. F. Carlsen's article, "Changes Two Motors and Saves $2,400 Per Year," and would like to have further information on this problem. Assuming that 3-phase power is delivered to a load at 85 per cent power factor from an outside source, what would be the effect upon the consumer's power consumption?*—H. B.

The power factor of the load on a line has no direct influence on the power factor of any individual load supplied by the line. It is the power factor of individual loads that determines the power factor of the line. For example, assume that a line is supplying a load of 300 kw. that has a power factor of 87 per cent. The power factor of the line is the same as the power factor of the load, or 87 per cent.

If a load of 200 kw. having a power factor of 71 per cent is added, the line will now supply a load of 500 kw. at a resultant power factor of about 80 per cent. The power factor of the 300-kw. load is still 87 per cent and that of the 200 kw., 71 per cent.

The power factor of the individual loads is determined by the class of equipment making up the load. If the load consisted of lightly loaded slow-speed induction motors the power factor might be less than 40 per cent lagging. A load consisting chiefly of synchronous motors might have a power factor of 100 per cent or it could be made leading. Loads including a combination of induction motors, synchronous motors, lights and other devices generally have a power factor that comes between the values given.

How to Find Excessive Oil in Steam-Engine Exhaust

Answers to the March Questions

THE QUESTION

Upon inspecting the boilers of a plant that I recently took charge of, I found considerable oil had been deposited in them, the oil coming from steam engine exhaust due to the fact that equipment for separating the oil from the steam had become clogged and ineffective. I would appreciate suggestions for a device that will indicate when the steam after it leaves the separator or the feedwater has excessive oil in it so that steps can be taken to overhaul the oil separator before the boilers become so fouled as to require cleaning. P.H.S.

Pressure Drop in Filler Shows When to Clean

IT MAY interest P.H.S. that there is a filter on the market which not only eliminates oil and grease, but also is the means of measuring the amount of oil and grease present in boiler feed or other water. The latter is accomplished by determining the pressure drop when the filter is clean and when the filter cloths used in the filter become saturated with oil and grease. In the latter case the back pressure builds up until the pressure drop through the filter indicates the time for changing the filter stockings.

While this device does not register the amount of oil and grease present on a recording device, nevertheless the weight of the oil and grease present can be determined by weighing the clean and fouled stockings over a given period of time. This is fairly accurate, as this particular filter absorbs to an entirely satisfactory degree the oil and grease present in the water.

New York, N. Y. A. O. MILLER.

Open Heater Gage Glass Shows Oil

DETECTION of oil in an open feed-water heater requires no elaborate device. If the heater has no gage glass, one should be installed with the middle of the glass at water level.

The heater should be pumped out or blown down at least once a day below the level of the lowest gage fitting. Any grease or oil in the water will show in the glass when the water rises to normal operating level.

The separator should also have a gage glass which should be examined regularly to make sure the separator is not clogged.

Oil should be used sparingly and a good grade of filtered mineral oil employed if trouble is encountered in separating the oil from the steam.

Milwaukee, Wis. L. M. LARSON.

Examine Feed-Water Sample For Oil

A SERIES of feed-water samples, drawn from the feed lines and allowed to settle for 15 or 20 min. in test tubes or glasses, will show upon examination whether an appreciable quantity of oil is present in the feedwater. However, after P.H.S. has thoroughly cleaned the clogged separator, the condition of oil in the feedwater should not occur again at any time if the separator functions properly. A gage glass connected to the reservoir portion of the oil separator will show whether or not the separator is becoming clogged.

That the separator became fouled and ineffective indicates that it was not provided with a grease trap or that the grease trap, if provided, was not working as it should. With most types of oil extractors, a grease trap is necessary effectively to discharge or remove the oil, grease, and condensation from the separator and thus prevent oil being carried with the exhaust steam beyond the separator. It is important that the discharge valve of the grease trap be of ample capacity for the size of separator used. The pipe connecting the trap with the extractor should be the full size of the extractor drain opening. A gate valve should be installed between the extractor and the grease trap for a shut-off to permit cleaning the trap.

Arlington, Mass. T. W. BEAN.

Obtain Self-Cleaning Separator

I HAVE had experience with different kinds of oil separators and find that there is no excuse for oil separators clogging to a point where they allow oil to pass by. The very fact that the oil separator, if clean, separates the oil from the steam satisfactorily, indicates that the oil does not contain enough compound to become excessively volatile and can be removed. Thus the fault lies entirely in the separator.

My suggestion is to look over the oil separators on the market and choose one that is self cleaning. Manufacturers will put them in without cost to prove this point, if you are in doubt. The size should be such that steam will not pass through at a velocity of more than 6,000 ft. per min. The pipe ahead of the separator should be straight for at least eight pipe diameters.

After installation, the trap should be inspected periodically to see that the unit is draining properly.

Chicago, Ill. G. J. KIPPER.

Dirty Filter Stops Pump

WE HAVE two reciprocating engines exhausting to paper machine dryers. There are two of the best known makes of oil separators installed on each engine exhaust line, one close to the engine and the other close to the dryer header. These separators function satisfactorily most of the time, but the traps which remove the separated oil and condensate have to be watched very closely, as they have a tendency to clog.

We found, however, that although the traps were kept in operating condition, excess amounts of oil entered the boilers, resulting in foaming and tube failures. Oil was getting by the separators during periods of high steam demand.

As oil in the dryers did not seem to affect heat transfer to any noticeable degree, we installed a pair of stocking oil filters between the hot-well pump and the feed-water heater. A pressure gage on each side of the stockings shows the drop in pressure through the stocking, thus indicates when they should be changed.

Whenever the pressure differential rises above 4 lb., the low-head hot-well pump can no longer discharge against the gravity head of the feed-water line, and

the hot-well over-flows to the sewer. This brings quick protest from the fireman. This rarely happens, as the stockings in each of the filters are changed about once a week, when the pressure drop reaches 3 lb. This keeps all oil out of the boilers except for a trace at the waterline.

If oil accumulates faster than usual in the stockings, as shown by the gages, a check usually shows that one or more traps on the separators are clogged. This system of oil removal from the exhaust steam and condensate is very nearly automatic and at the same time inexpensive.

Escanaba, Mich. A. H. WADEWITZ.

Flexible Diesel-Compressor Refrigerating Plant

The Question

We are planning to install a 100-ton refrigerating plant, the machines to be driven by direct-connected oil engines. Demand varies over a fairly wide range. Should we install two compressors driven by separate engines or a single engine-compressor set which would run at half speed when demand iss low? Or would two separate diesels one half the size of the other and both clutched to the same compressor (larger taking peak load, lower taking low) work out best? L.E.C.

Avoid Clutches or Other Complications

THESE remarks are backed up by several years' operation of plants of this identical type. Diesel engines should be direct-connected to ammonia compressors without clutches or other complications. If the refrigeration demand is variable, this problem is best met by installing a compressor of the type which has one end that can be cut out for half-capacity operation by removing the suction valve and seat, or by cutting in suitable pockets built into the cylinder. Diesel engine operation at half load is almost as efficient as at full load. It is not advisable to attempt operating a diesel engine of the ordinary type at widely different speeds.

New York City. DAVID DASSO.
Representative, Sulzer Bros.

Two Sets Give Variation

ASSUME (actual conditions not being given) that 150 hp. is required to develop 100 tons of refrigeration. Then the ideal installation for maximum efficiency under varying conditions would be obtained by two diesel-compressor sets, one to have a 100-hp. diesel and a 70-ton compressor, the other set to consist of a 50-hp. diesel and a 30-ton compressor. Then for light loads (15-30 tons) the small set would be working in the upper half (most efficient) of its range. For medium loads (30-70 tons) the larger set, alone, would be working in the upper half of its range. For heavy loads (70-100 tons) both sets would be running in parallel, the smaller set carrying 25-30 tons, at maximum efficiency, and the larger set the remainder (40-70 tons) approaching its maximum efficiency. Under such operating conditions, the large volumetric loss of compressors at light loads is avoided, as are also the large (proportionately) fixed losses in diesel engines operating at less than half load.

In addition there is increased reliability due to two independent machines, either of which can carry a good share of the load.

Annapolis, Md. VINCENT H. GODFREY.
U. S. Naval Engineering Experiment Station

Two Questions for Our Readers

Question 1

WE ARE using steam at 90-lb. gage pressure in pipe coils to heat water in a 2,000-gal. uninsulated steel tank. The tank is filled three times a day with water at about 60 deg. and heated to 190 deg. in about one hour. Will any saving of steam result and, if so, about how much if a reducing valve is installed to reduce the steam pressure to 25 lb. before the tank coils?—C. R. S.

Question 2

WE HAVE a 135-hp., 300-r.p.m., 4-cycle, solid-injection diesel engine supplying power for our flour and feed mill. Exhaust gas temperature is 400 deg., jacket water temperature 120 deg., and load is fairly steady. Can we utilize jacket water and exhaust gas heat, and, if so, how much waste heat can we expect to regain for use in our low-pressure steam heating system? What sort of equipment would be used?—H. M. V.

Suitable answers from readers will be paid for if space is available for their publication.

Every Unit Should Have a Duplicate

I WOULD recommend two diesels direct-connected to compressors, one small and one large. Thus several capacities are provided for load variations, and there is always capacity available when a unit requires repair. This allows the plant to be kept in much better repair.

Lima, Ohio. JOHN L. WHITE.

Install Three Units

IF CONTINUOUS operation is necessary, L. E. C. should install three complete 50-ton units. This will allow one to be shut down for repairs at all times. If the variation in load is not too great, I would suggest that L.E.C. install one diesel-compressor unit, the variation in load being taken care of by increasing the clearance volume by pockets. The decrease in volumetric efficiency would not affect compressor efficiency to a point at which it is impractical if the equipment is not operated at under three-fourths load. If load conditions vary more than this, one diesel with two compressors might be used. One 40-ton and one 60-ton unit could be clutched to opposite ends of the engine shaft. The diesel offers good fuel economy over a wide range of loads at constant speed, and three different compressor capacities are provided. Timing difficulties and low efficiencies make variable speed operation of the diesel impractical.

Walthill, Neb. WM. W. DINGWALL.

Two Units, Separately Driven

TWO COMPRESSORS, driven by separate engines, would be best. During low-load periods, one would be available for repairs without interruption to service.

Baltimore, Md. J. A. RAMBERTH.

Purchasing and Operating Economy

WHEN installing new equipment, economy in first cost should be considered as well as economy in operation. According to my experience, the logical installation would be one oil engine direct-connected to two double-cylinder single acting vertical compressor units. The oil engine would be clutched between the units. Compressor cylinders should be equipped with clearance pockets to provide 25, 50 and 75 per cent load operation. This provides a wide variation in efficient capacities, as well as permitting one unit to be uncoupled for repairs at any time.

Glenolden, Pa. D. S. BOUSUM.

Remember First Cost

THIS appears to be a simple question, if only the operating side is considered. While I am not inclined to be niggardly in buying or installing the best equipment or arrangement for any type of plant, I still do not believe that the plant should tie up a large sum of money that would hobble the plant for a number of years. The first task, then, is to get comparative prices.

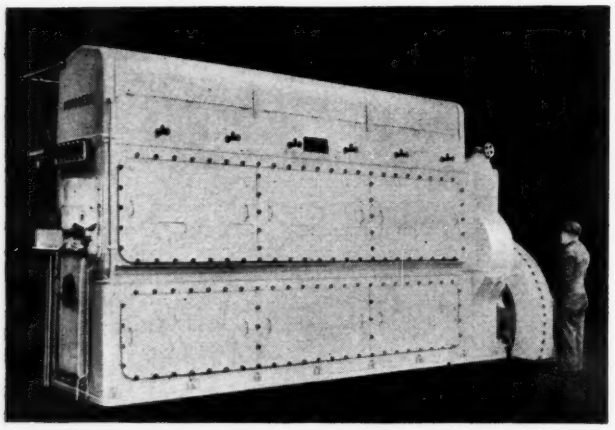
If there is not too great a difference in price, I would install two separate, direct-connected 50-ton compressors, as this provides standby and permits proper maintenance and repair. A story of my early days may illustrate the point. I once worked in a small portable saw mill, the owner of which made money when others around him went broke. His secret came out when he hired a new sawyer. When he came to the mill unexpectedly one day, he found it shut down to permit the sawyer to file the saw. The owner told the sawyer in unmistakable language to get the hell off of there and put on another saw, for, said he, "The only way to make money is to keep a saw in the log *all the time.*" This is a good point and one that is too often forgotten. The installation I suggest will permit L.E.C. to run on at least half capacity while troubles are corrected.

Jefferson, Ga. W. H. PENDERGRASS, SR.

Look Around for Examples

FURTHER light may be shed on this question by the four illustrations on page 232, under the title, "Oil and Gas for Ice-Plant Drives." These show four types of set-ups in accord with latest practice—EDITOR.

WHAT'S NEW IN PLANT EQUIPMENT



Four-Cycle, 250-1,000-hp. Diesels

Formerly, Nordberg built large, 2-cycle engines only; this line (Types FS-16) includes units from 250 to 1,000 hp. operating 4-cycle and smaller units from 150-300 hp. Radically new is complete enclosure, even at top, flywheel being only visible moving part. Trunk-piston, solid-injection type. Force-feed lubrication for cylinders; other parts lubricated by continuous-pressure system. Force pump, driven from crankshaft and located in bedplate sump opposite flywheel end, forces oil to main, crank-pin and wrist-pin bearings. Secondary system oils cam shaft, governor, guides and valve mechanism. No hand oiling required. Bedplate casting designed to support cylinder block directly. Long through bolts from below main bearings to top of cylinder block tie these castings together.

Removable liners in cylinder block. Engine controlled by single lever at end opposite flywheel and giving three positions, start, run and stop. Individual fuel pumps for each cylinder mounted to cylinder back and set directly over camshaft adjacent to cylinder served. Facility for hand operation. Complete piping systems attached to engine for cooling water, starting air, fuel and lubricating oils, exhaust. All incoming air passed through filters in upper covers on exhaust side. Other built-in elements include fuel-transfer pump (delivers fuel oil from service tank to header) pressure strainer and cooler for lubricating oil and fuel-oil filter. Gage board with air, oil and water pressure gages mounted on end of engine. Bulletin 51.

Nordberg Manufacturing Co., Milwaukee, Wis.

8,000 to 40,000-lb. per Hr. Steam Generator Unit

C-E steam generator units are standard design in sizes for capacities of 8,000 to 40,000 lb. of steam per hr. Economical in first cost and operation, compact and can be fired by pulverized fuel, oil or gas. Assembly of standard equipment. Low headroom and small floorspace. Unit comprises 2-drum vertical boiler and furnace with solid brick walls, top and front being water-cooled by tubes connecting into upper boiler drum and terminating in a header in lower front wall. Water screen across furnace bottom connects this header with lower boiler drum. Pulverized fuel fired horizontally by natural-draft burner supplied by Raymond impact pulverizer mill at front or on one side. Boiler can be arranged for either two or three gas passes and may be equipped with superheater. Single contract and performance guarantee covers entire unit.

Combustion Engineering Corp., 200 Madison Ave., New York City.

Compensated Air-Cell Battery

For use with Brown potentiometers, this battery eliminates frequent standardizing. It has constant-current output and 2½-yr. life to provide continuous accuracy without attention. Bulletin from:

Brown Instrument Co., Philadelphia, Pa.

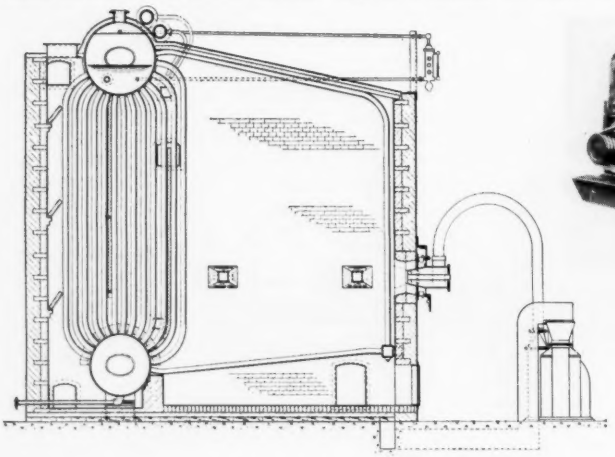
Lubricating Paste

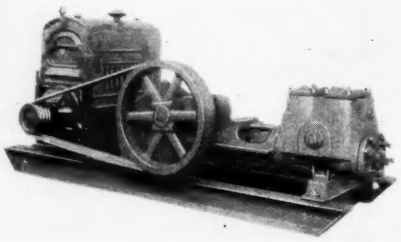
Garlock lubricating paste compound No. 2 for steam and water packings, and No. 3 for packings working against gasoline and oils, contain high-grade ingredients, and are intended to replace hand-mixed lubricating compounds frequently used for packings. Claimed to reduce friction, obtain maximum efficiency, and prolong life of packings in service.

Garlock Packing Co., Palmyra, N. Y.

Gasoline Engine-Driven Double-Acting Power Pump

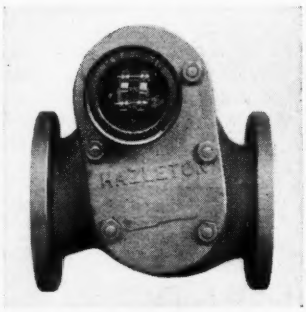
This gasoline engine driven unit consists of a 4x6 Gardner-Denver horizontal duplex double-acting power pump connected by V-belt drive to a 4-cyl., 4-cycle vertical gasoline engine power unit, all mounted





on rigid H-beam steel skid with provision for tightening V-belts by moving engine with jackscrews. Used principally for water supply. Bulletin P-36.

Gardner-Denver Co., Quincy, Ill.



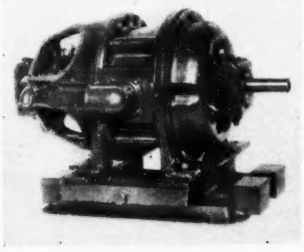
Check Valve With Mercoid Flow Switch

This Type M check valve fitted with Mercoid flow switch is designed to shut down pump if it loses its water during operation. Switch is connected into low-voltage coil of motor starter and is actuated by valve flap. When pump is in operation and delivering water, flow through valve raises flap and closes switch. When pump loses water, flap falls, switch opens and stops pump. Switch can be arranged for either horizontal or vertical mounting of valve.

Barrett, Haentjens & Co., Hazelton, Pa.

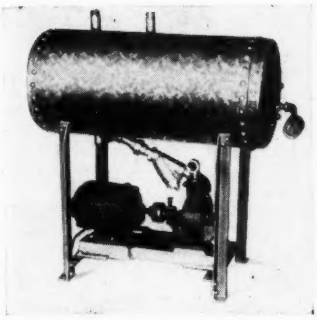
Sound-Isolating Motor Base

Floating members of this base are suspended on specially developed material. Motor on standard sliding base, and belt tension and motor alignment maintained in usual manner. Adjusting screw moves motor for belt adjustment. Bases in-



stalled as units. Stiffness of sound-isolating material is sufficient to maintain motor alignment for any reasonable belt tension. Guide washers in machined grooves are used with belt-adjusting feature to maintain motor alignment. Bases available for following motor ratings and speeds: Polyphase induction motors of 1 to 50 hp., 900 r.p.m.; ¾ to 30 hp., 1,200 r.p.m.; 1 to 3 hp., 1,800 r.p.m. Single-phase motors of ½ to 2 hp., 900 r.p.m.; ½ to 2 hp., 1,200 r.p.m.; 1 to 5 hp., 1,800 r.p.m.

General Electric Co., Schenectady, N. Y.



Automatic Boiler-Feed Unit

Improved M-K-O automatic boiler-feed unit will pump feed water against high boiler pressure and maintain constant water level. Also returns condensation to boiler and supplies make-up water. Has high-speed motor-driven turbine pump instead of former tandem pumps. "Flat" head supports valve and float of make-up water control instead of former larger device. Angle-iron legs bolted to brackets welded to tank reduce floor space and decrease space.

Mears-Kane-Ofeldt, Inc., 1903 E. Hagert St., Philadelphia, Pa.

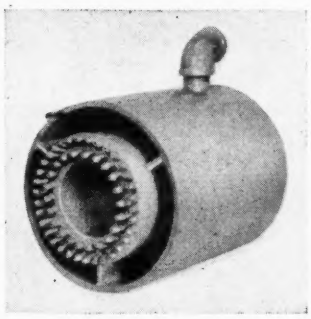
Heavy Centrifugal Separator

Sharples Rotojector Centrifugal (Titan Patents) is capable of continuous operation on liquids containing relatively high percentage of solids. High centrifugal force. Operating or working chamber in bottom of centrifugal bowl assembly can be operated while at full speed to open bowl by hydraulic pressure whenever desired, and expel entire contents of bowl within ten seconds. To handle liquids with percentages of up to 10 of amorphous and slurry precipitates; or for up to 10 of solids, can be used on dirtier Bunker C oil and in dehydration of tar made with Bunker C oil in the manufacture of utility gas.

Sharples Specialty Co., 23rd and Westmoreland Sts., Philadelphia, Pa.

Gas Burners

Ritter burners are claimed scientifically correct, because of cylindrical construction, and to achieve complete combustion at all times. Can be installed easily in any type of burner. Simple to operate, flexible. Can be adjusted to higher or lower gas pressure, and meet chang-



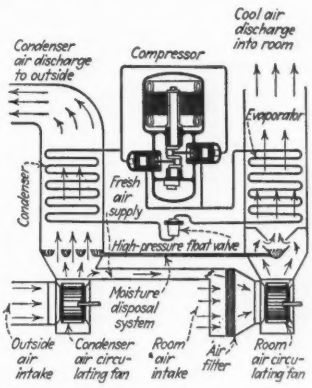
ing power conditions automatically. Can be operated with automatic controls and with automatic burner damper. Vibrationless, and operate properly with either natural or forced draft. Do not deposit soot. Emergency oil burner standby can be inserted through center core of burner in 30 sec., without affecting burner setting, and, if desired, oil and gas may be fired at the same time.

Ritter Gas Burner Corp., P. O. Box 321, Fort Worth, Tex.

Dust Extraction and Collection System

United States patent rights for the Simon-Carves dust extraction and collection system have been obtained by Link-Belt. Illustration shows general arrangement and principle. Raw coal is carried to system by conveyors, elevators or other means, delivering into bin down spiral chute. Bin is fitted with control gate which regulates amount of feed to shaking screen. Air is blown from fan through duct leading up through screen. Thus the dust blown out carried through top duct to a cyclone, where it settles, and is taken out through dust chute at bottom. Large coal passes over screen and is delivered by chute into wash box or storage bin. Eccentric driving shaft of screen runs at 150 r.p.m. Entire mechanism driven by one motor using countershaft. No cascading of coal. Cyclone measures only 4 ft. 6 in. in diameter, making entire system compact. A 20-hp. motor will drive 50-ton dust plant.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.



Unit Air Conditioner

Designed for use in offices, retail establishments, hotels and clubs, one unit conditioner in a room of approximately 5,000 cu.ft. is capable of effecting a reduction in temperature of 10 to 15 deg. Feature of this unit is ability to change from cooling and dehumidifying unit into warming and humidifying unit without an auxiliary heating system. By turning one lever, the newly applied reverse refrigeration cycle is brought into action Another feature is that condensation from air-cooling coils is used in condenser section of refrigerating unit to aid in condensing refrigerant In this process, condensed water vapor is evaporated and so discharged outdoors when acting as a cooler or indoors when reversed. Compressor is 2-cyl. opposed vertical-shaft unit directly connected to totally inclosed vertical motor. Driven by 2-hp. motor and has refrigerating capacity equivalent to 1½ tons of ice meltage per 24 hr. Refrigerant is Freon. Unit operates entirely by electricity, requiring an outlet sufficient to carry 2 kw. It is air-cooled and requires no piping whatever, either supply, drain, or refrigerant. Valves for reversing refrigeration cycle not shown.

De La Vergne Engine Co., Sales agent for the Baldwin Southwark Corp., Philadelphia,

Change in Name

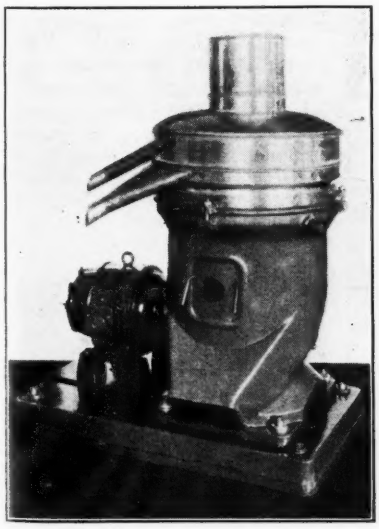
From now on, line of control instruments manufactured and sold by the Mason Regulator Co. and Neilan Co., Ltd. (Division of Mason Regulator Co.) will bear a new trade-mark, an oval with "Masoneilan" spelled across long axis. This trade-mark will be used by both companies.

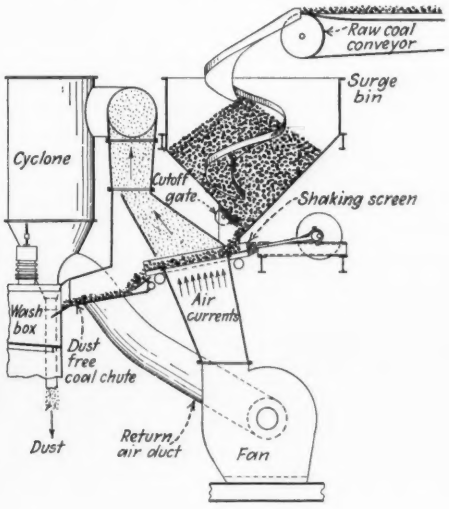
Mason Regulator Co., 1190 Adams St., Boston, Mass.

6x9-in. Vertical Gas Engine

This vertical four-cycle gas engine enlarges the National line to give range from 20 to 1,500 hp. Engine is designed so that it can be changed readily to a solid-injection diesel, and will operate economically on either natural or refinery gas. Moderate-speed engine for heavy-duty service and long life, to fill gap between large slow-speed engine and small high-speed engine. Compact, self-contained, and all moving parts inclosed. Equipped with regulating valve mechanism used on National horizontal type engine. Automatic lubrication system. Furnished with two, three, four or six cylinders; sizes 20 to 100 hp. Bulletin No. 430.

National Transit Pump & Machine Co., Oil City, Pa.

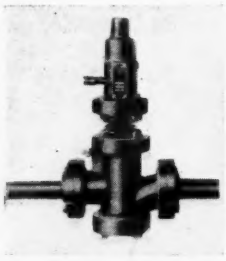




Area-Type Flow Meter

Brown area-type flow meters measure flow of fluids, such as heavy oils, chemicals, etc., and body is installed directly in pipe lines without seals or auxiliary piping. Meter-body is of piston and sleeve type. Position of piston measured by inductance bridge system, reading on evenly graduated scales and charts. Meter claimed extremely accurate at low flows as well as at large. Meter range adjustable by adding weights to piston cup and using different-sized orifice sleeves. Piston area 5 sq.in. Ranges in measuring water and similar flows from 0 to 150 g.p.h., to 0 to 2,000 g.p.h. maximum. Meter capacity is less for fluids with lower specific gravities.

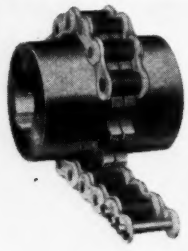
Brown Instrument Co., Philadelphia, Pa.



Roller-Chain Flexible Coupling

"RC" Silverlink roller chain is used in this flexible coupling, consisting simply of two cut-tooth sprocket wheels or coupling halves and a piece of roller chain to connect them, all working surfaces being machined to close tolerances. A pin-and-cotter link makes it simple to couple or remove chain. Unit can be inclosed in a stationary or revolving automatically-lubricating oil-retaining casing. All sizes and types listed in folder available.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.



Automatic CO_2 Indicators & Recorders

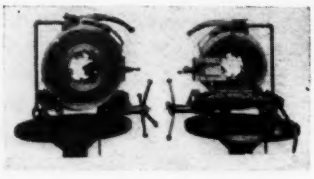
Hays automatic CO_2 indicators and recorders are used for CO_2 indication only; CO_2 and draft; CO_2, draft and flue gas temperature; or CO_2 and flue gas temperature; in either flush, panel or wall-mounted types. Also, as is true of company's automatic CO_2 recorders, analyzer section may be placed up to 100 ft. from indicator case, to reduce lag and provide up-to-minute information on CO_2 content of waste gases. Illustrated is indicator which provides reading of CO_2 content, flue gas temperature and amount of draft.

Hays Corp., Michigan City, Ind.

6-in. Die Head

No. 706 die head can be installed in old pipe machines. Makes any 6-in. pipe machine cover all sizes from 1 to 6 in., and bolts from ¾ to 5 in. Head calibrated for Briggs Standard, but can be marked special to suit requirements. Micrometer adjustment for over or undersize threads. Threading dies high-speed steel, five to a set, of small segmental type mounted in holders. Single segments replaceable. Cutting oil pumped through head to threading dies; one stream of oil directed in front of cutting edge by means of full cascade method. Head equipped with single high-speed cutting blade on gibbed slide, screw-operated.

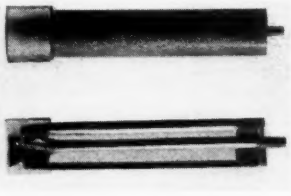
Oster Williams Corp., Cleveland, Ohio.



Boric Acid Power Fuse

A new de-ion power fuse for outdoor or indoor service, with interrupting capacity up to 600,000 kva. Extends range of applications of fuses to locations requiring heavier duties than were possible. Three voltage ratings—7,500, 15,000 and 23,000—with renewable fuse elements in standard current steps from 5 to 200 amp. Interrupting capacity varies with voltage ratings only. Change in current rating of fuse link does not affect rupturing capacities at given voltage. Calculated on basis of three-phase power, the three standard voltage ratings of 7.5, 15 and 23 kv. have interrupting capacities of 325,000, 500,000 and 600,000 kva.

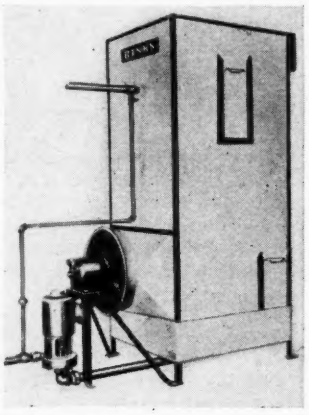
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



Indoor Forced-Draft Cooling Tower

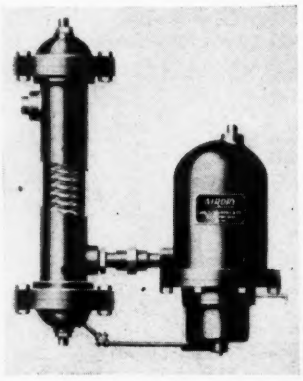
Binks Type FD indoor forced-draft, spray-cooling towers will cool and recirculate water for ice machine condensers, diesel engines, compressors, heat exchangers and other types of water-jacketed or water-cooled equipment. Can be used in congested districts and in buildings of more than average height. Furnished as complete self-contained operating unit, with or without water-circulating pump. Circulating pump can be mounted as shown or can be located at any convenient point between process and tower proper. Special Binks patent "Rotojet" clog-proof nozzles. All sizes for refrigerating and industrial application. In capacities of 5 to 50 g.p.m.

Binks Mfg. Co., Cooling Equipment Div., 3114-40 Carroll Ave., Chicago.



Automatic Air-Drying Device

Murphy aftercooler-separator "airdry" combination, claimed practically 100 per cent efficient in delivering clean dry air. Separator fastened to aftercooler by pipe and union connections on smaller sizes, and by flanged connections on larger.



Condensation in both aftercooler and separator descend into built-in automatic trap, and are ejected as fast as collected. Sizes from 5 to 150 cu.ft. free air per minute. Larger sizes for any capacity built to order. Aftercooler of counter-current flow design.

James A. Murphy & Co., Hamilton, Ohio.

Refractories

"Fireco" refractory and special products designed to requirements. Concrete for refractory shapes and monolithic linings, known as "Firecast," in 100-lb. bags. "Fireset" cements for bonding and coating refractories and firebrick, adhesive, airsetting refractories, vitreous and gas-tight. Shipped in air-tight resealable steel drums from 1- to 500-lb. sizes. "Firecoat" prepared coating material for furnace walls and refractories, has paint consistency with good adherence and surface protection. Shipped in steel drums. "Firepatch" plastic refractories for molding and patch repairs have low shrinkage, are adhesive and plastic, and refractory. Shipped in 100-, 250- and 500-lb. resealable drums. Complete information from:

Findlay Refractories Co., Findlay, Ohio.

Transparent-Cup Goggle

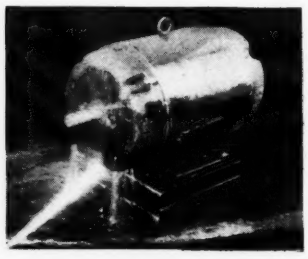
Cups of new Willson goggle are of transparent material, permitting light to pass through cup walls undimmed, and giving entirely normal eye condition. The goggle is sturdy, spark-proof, and light. Can be worn over spectacles.

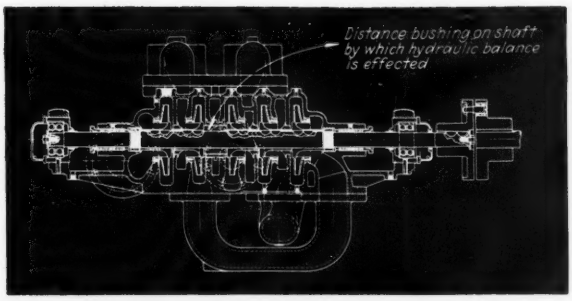
Willson Products, Inc., Reading, Pa.

Splash-Proof Motor

Baffles placed in air ducts of motor remove all spray from air entering motor and keep windings dry. Simply standard induction motor using special bearing brackets. All sizes from 1 to 200 hp., as squirrel cage induction motors. Also available as across-the-line start motors up to 200 hp., and can be supplied as unity or 80 per cent leading power factor induction motors in all sizes.

Ideal Electric & Mfg. Co., Mansfield, Ohio.





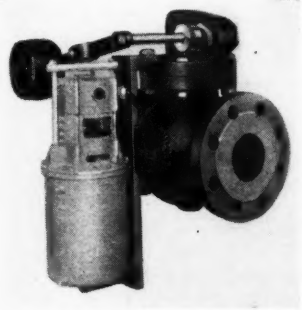
Hydraulic Balance in Multi-Stage Centrifugal Pumps

Impellers of Pennsylvania multi-stage centrifugal pumps are arranged so that suction inlets are opposed. Where number of stages is even, as in 4-stage pump, half of impeller inlets face left-hand, half right-hand. In 3-stage pump, suction inlet of one impeller faces left-hand, other two right-hand. In 5-stage pump, two impellers have suction inlets facing left-hand, other three right-hand. In all pumps, at about center line, two impellers are directly opposed. Balancing is accomplished by placing properly proportioned distance bushing between two directly opposed impellers, diameter of this bushing being of value to put rotating element in complete hydraulic balance. In addition, ball thrust bearing is incorporated in outboard bearing to take care of unusual conditions, such as introduction of foreign material and to insure proper alignment of rotating parts. Avoids leakage and excessive wear and gives positive hydraulic balance over practically entire range of capacity head, regardless of number of stages.

Pennsylvania Pump & Compressor Co., Easton, Pa.

Thrustor-Operated Control Valve

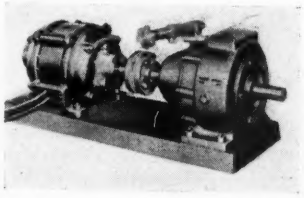
Copes Thrustor-operated control valves provide centralized remote control of flows of gases or liquids under pressure. Operated by a G. E. thrustor mounted at side of valve by bracket bolted to valve bonnet. Thrustor operates in one direction only, weight acting to return valve to original position when circuit is broken. Controlled by push button or time switch; external adjustment provided. Valve can operate up to 40 times per minute without injury. No limit switches. Either 110, 220 volt, 60 to 25 cycle, a.c., 125 or 250 volt d.c. Valve is Copes Type BI, designed for specified pressure drop and flow and balanced under flow conditions. Rotating valve stem in stuffing box to reduce friction. Bronze, Monel metal or stainless steel fittings in sleeve type or tight-seating.



Northern Equipment Co., Erie, Pa.

Variable Speed Reducer

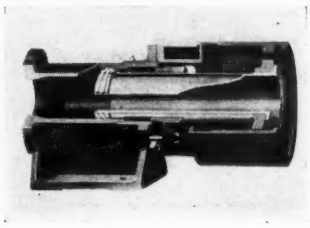
Illustrated is Johnson variable reducer connected to 1-hp., 1,200-r.p.m. motor. Composed of five over-running clutch units. Is self-contained, infinitely variable unit running in bath of oil, using control that is visible and quickly manipulated. Stopping action claimed superior to that of clutch, since unit stops instantly, having slight inertia. Noiseless and high efficiency. Capacity 1 hp. up., speed 0-240 r.p.m.; step-up for higher speeds.



The Smith Power Transmission Co., Penton Bldg., Cleveland, Ohio.

Externally Guided Piston-Ring Expansion Joint

ADSCO 400-lb. piston-ring expansion joints sizes from 3 to 20 in. in single- or double-slip design; traverses 3 to 11 in. per slip; 400-lb. A.S.M.E. flanges or ends beveled for welding, with or without shield over gland stud openings, and with cast iron or cast steel bodies. Joint may be repacked without shutting off steam. Piston head, with two special rings, is held in alignment with machine body cylinder. Before packing gland is removed for repacking, relief valve is opened to relieve pressure between piston head and stuffing box. Piston rings then hold line pressure while stuffing box is being repacked, and vent discharges any slight leakage.



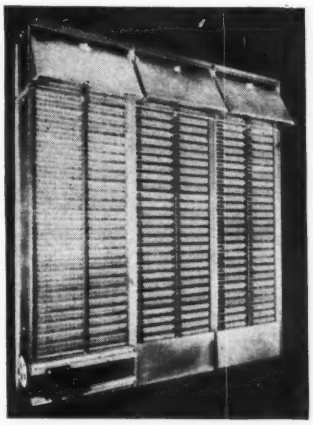
American District Steam Co., North Tonawanda, N. Y.

Heavy-Plate Electric Welding

Murex straight gap welding does away with all need for "veeing" or grooving of plate edges. Greater welding speed, as well as appreciable cost reduction, are claimed. Tests claimed to show that straight gap welds are physically superior in many ways to normal welds.

Company has also added Murex heavy mineral-coated electrodes, known as Universal, for use on mild steel in flat, vertical or overhead work. Give smooth clean deposits of high tensile strength and ductility.

Metal & Thermit Corp., 120 Broadway, New York, N. Y.



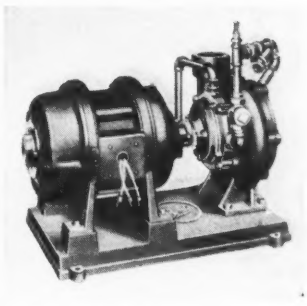
Aluminum Air-Filter Unit

"Alcoa" aluminum was used throughout this self-cleaning type air filter to increase endurance and lengthen life.

Independent Air Filter Co., Chicago, Ill.

Single-Suction, Self-Priming Pump

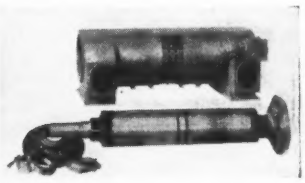
Buffalo "CP" is new compact, economical type with cast-iron casing and template-drilled suction side-plate with close clearances on impeller. Two types of impellers available: open, where liquids are not clear, and enclosed impeller for clear liquids. Bronze impellers normally supplied but cast iron or other metal can be furnished. Built-in self-primer, under license from Nash Engineering Co., mounted as integral part of pump casing. Pump shaft, bronze covered, is extension of motor shaft, carrying impellers for pump and primer. Thus no bearings are used on pump, both radial and thrust loads being taken by motor bearings. No coupling required. Gland split type, cast iron or bronze on special order. Unit complete in several sizes in capacities up to 450 g.p.m. and heads to 150 ft.



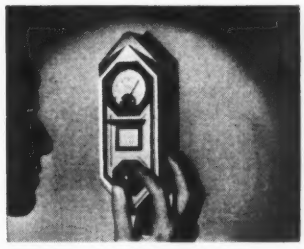
Buffalo Pumps, Inc., Buffalo, N. Y.

Small-Diameter Motor

100-hp., 1,760-r.p.m., 60-cycle, 3-phase, enclosed, pipe-ventilated, horizontal, ball bearing, squirrel-cage motor has diameter less than 12 in. Distance from shaft center to flat on motor top, 5 1/8 in. Separate motor-driven blower for ventilation.



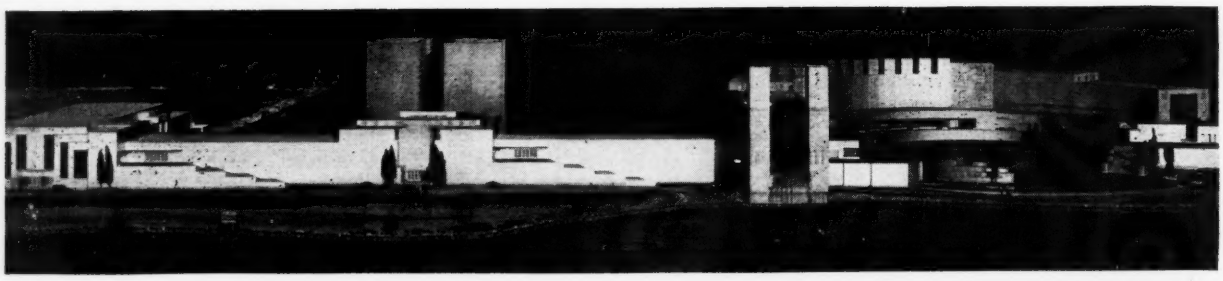
Louis Allis Co., Milwaukee.



Multi-Temperature Indicator

This temperature recorder measures entire range from ice point to steam point. It is accurate, and can be plugged into any electric light socket and wired up with bell wire to search coils at as many extensions or points as necessary, since it is dialed to the point from which temperature reading is required.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



Electrical unit of Chicago's Century of Progress (to open June first) lies between the lagoon and Lake Michigan. Great semi-circular unit at right houses exhibits picturing the generation, transmission and application of electricity. Straight building in center is devoted to communications

POWER LINES

1932 Electricity Production Down Only 15 per cent

The final report on electricity production in the United States in 1932, just released by the Department of the Interior, shows that a total of 83,153,000,000 kw.-hr. was produced for public use in 1932. Of this total, 41% was produced by water power and 59% by fuel. The total output in 1932 was 9.4% less than in 1931, which in turn was 4.4% less than in 1930, and the output in 1930 was 1.5% less than in 1929, the year of maximum output. Output by the use of water power in 1932 was 11.4% greater than in 1931, and output by the use of fuels was about 20% less than in 1931. Total output in 1932 was about 14.5% less than in 1929. The increase in efficiency in the use of coal, oil and gas in generation accomplished consistently each year since 1919 was continued during 1932. The average amount of coal and coal equivalent of oil and gas consumed in generating 1 kw.-hr. of electricity at public utility plants was 1.50 lb., as contrasted with 3.2 lb. in 1919. Copies of the report may be obtained from the director, United States Geological Survey.

Behavior of Long Beach Plant During Recent Earthquake

Facts on behavior of the Long Beach Steam Plant of Southern California Edison Co. during the recent earthquake have been furnished by Stone & Webster Engineering Corp. who designed and constructed Plants Nos. 2 and 3 with installed capacity of 345,000 kw. That the shock was severe in this location was evidenced by a settlement in the ground of from 3 to 12 in. The only unit in Plant No. 2 in service at the time of the shock was carrying 25,000-kw. load. This unit continued in operation without interruption. There was no damage to the building, equipment or piping. Some leaks occurred in minor piping around the yard.

In the 220,000-volt bus structure, both at Long Beach and at Lighthipe Substation, the post insulators on which the bus was supported, proved to be too rigid and the bus fell over. As the No. 3 Plant serving the 220,000 volt bus at Long Beach was not in operation, there were no short circuits at this point. The No. 2 Plant was in operation through the 66,000-volt control house, which was undamaged.

There was an interruption of service of 4½ min. in Long Beach due to the 220,000-volt bus failure at Lighthipe.

Buildings housing No. 2 and No. 3 Plants have structural steel frames with reinforced concrete floors and walls on continuous mat foundations carried on 50-ft. wood piles. Turbine supports are massive reinforced concrete structures. The stacks are of reinforced concrete superimposed on the steel frame of the buildings.

Engineers attribute the satisfactory performance of the plant at the time of the earthquake to the type of foundation adopted, the use of reinforced concrete for walls, turbine supports and chimneys; also to the conservative assumptions made in providing for the horizontal forces resulting from earthquakes.

Copenhagen Diesel to Operate May 1

According to a recent letter from the chief engineer of a Copenhagen, Denmark, electrical plant, the 22,500-hp. Burmeister & Wain Diesel (*Power*, Oct, 1932) largest diesel engine in the world, should be ready for turning over by May 1. In addition to this installation several other diesels of considerable size have been installed recently in Danish power stations, notably those at Odense, about 5,000 kw., and Randers and Esbjerg, 3,000 kw.

National Lubrication Meeting Scheduled May 25-26

The Second National Lubrication Engineering Meeting, to be held at Pennsylvania State College, May 25-26, under the joint auspices of the College and the Lubrication Engineering Committee of the Petroleum Division, A.S.M.E., includes several papers of interest to power engineers. The program includes "Practical Interpretation of Lubricant Specifications," by J. G. O'Neill, "Machine Design for Lubrication," by E. M. Barker and C. C. Davenport, "Roll Neck Lubrication", by W. D. Hodson, "Lubricant Viscosity Standardization for Industrial Equipment", by Dr. A. E. Becker, "Applications of Extreme Pressure Lubricants to the Lubrication of Industrial Machinery", by Dr. O. C. Bridgeman, "Problems of Lubricating Heavy-Duty Gears", by Austin Kuhns, "Wire-Rope Lubrication: (a) Hemp Core, (b) Wire Strands, (c) Relubricating in the Field", by A. J. Morgan, "Discussion on Friction of Wire Ropes in Sheaves", by L. M. Tichvinsky, "Some Practical Factors Affecting Design and Operation of Bearings for Large Rotating Apparatus", by T. W. Gordon.

Diesel Engineers Plan to Meet in Atlantic City

The Sixth National Conference of the Oil and Gas Power Division, A.S.M.E., will be held at the Ritz-Carlton Hotel, Atlantic City, Aug. 23 to 26, according to the announcement by Louis R. Ford, chairman of the Executive Committee. A special "all cost" rate of $20.50 for the three and one half days has been offered by the hotel, including best rooms, all meals, automobile open-air garage, bus to and from trains, bathing privileges, an orchestra for the "get-together" in the Grill Room, a card party, a banquet, meeting rooms, parlors and a ladies' tea, and tips for employees. Technical papers to be presented include "Welding of Diesel Parts", by Everett Chapman, Lukenweld, Inc., "Pressure Waves in Pump Piping", by Ralph Miller, Ingersoll-Rand Co., "Effect of Altitude on Engine Performance", by Prof. H. H. Everett, Penn. State College, "Supercharging of Diesel Engines", by Charles G. Curtis, "Low Compression Oil Engines", by Prof. F Dutcher, Columbia University, "Choice of Diesel Plant Auxiliaries", by Ralph Troseth, "Effect of Controlled Turbulence", by M. S. Huckle and C. F. Taylor, M.I.T., "Report of the A.S.M.E. Sub-Committee on Oil Engine Power Costs", Fuel Committee Report, and an address by E. B. Pollister, President of Busch-Sulzer Bros., Diesel Engine Co., at the banquet on "Sea Power and the Diesel Engine". The accessory exhibit will be displayed in a corridor leading to the hall where the meetings will be held.

Low-Cost Efficient Plant Addition Starts at Taunton

Construction has begun upon a 7,500-kw. addition to the steam plant of the Taunton (Mass.) municipal lighting department, and the consulting engineer for the job, Arthur

L. Nelson Engineers, Boston, estimates that the work will be done at a total cost of less than $50 per kw. The addition includes a B. & W., stirling type boiler to deliver 100,000 lb. of steam per hr. at 450-lb. gage pressure and 725 deg. F. total temperature; a Westinghouse turbo-generator of the extraction type; 8,500 sq.ft. surface condenser and auxiliaries, with Ljungstrom air preheater. The turbine water rate guarantee is 9.4 lb. per kw.-hr. at the throttle at full load, and the guaranteed overall efficiency of the boiler, superheater, air preheater and furnace at full load is 84.1 per cent. These rates are comparable, because of improved designs, with those previously available to much larger stations under highly favorable conditions. The present rating of the plant is about 8,000 kw., and it has a 5,000-kw. interconnection with the Montaup Electric Co. An important element in the decision to expand the plant at this time lies in the anticipated sale of industrial steam to local manufacturing plants.

A. S. H. V. E. to Meet in Detroit

The program for the semi-annual meeting of the American Society of Heating & Ventilating Engineers at the Hotel Statler, Detroit, June 22 to 24, includes reports on "Test Results on the Conductivity of Different Grades of Lumber", "Heat Dissipation from Insulated Hot Water Pipes", "Measurement of Air Flow Through Grilles", "Heat Output from Concealed Radiators", "Air Stratification in Assembled Halls", and a series of reports and data from the A.S.H.V.E. Research Laboratory. A general program of entertainment and inspection trips are also included in the two and a half day meeting.

Massachusetts to Retain Smoke Abatement Work

The Massachusetts law abolishing the smoke abatement division of the Department of Public Utilities does not mean that the state has abandoned smoke abatement work. The law was passed purely as an economy measure. Under the revised régime the Public Utilities Department is authorized to carry on the work of smoke abatement in the Boston region, delegating its administration to properly qualified assistants; but inspection of new installations will be dropped.

Since 1910, when smoke abatement work began at Boston, the area covered has increased from 62 to 291 sq. miles. About 2,500,000 observations have been made. Cost of the work per observation, according to a statement by David A. Chapman, director of the division, is 1.1 cents per year per $1,000 of assessed valuation, or less than half the expense of laundering a collar. In the fiscal year 1932 there were 231,976 observations and 1,165 violations. Only 4 court cases were required. Due to the depression much more soft coal than usual has been burned, and the division has aided many concerns to burn cheaper grades of fuel smokelessly by making slight changes in their boiler plants.

To a representative of *Power* Chairman Attwill of the Massachusetts commission said that the smoke abatement work will be carried on with vigor and efficiency under the new law, but he declared that it has been a mistake for the state to inspect new installations and approve their engineering design, since this makes the state responsible for the results rather than the plant operators.

Proposed American Standard For Machine Speeds

A proposed American Standard for Machine Speeds has been developed recently by the Sectional Committee on Speeds of Machinery, A.S.M.E., and is now being distributed to industry for criticism and comment. It is intended to apply generally throughout industry to the speeds of both driving units and driven machines.

A comprehensive code covering the installation, maintenance, and use in buildings of piping and fittings for city gas has been approved by the American Standards Association as American Recommended Practice. The code embraces practically every point of gas installations in buildings from the entry of the lines to connections to appliances. It gives precautions to be observed in installing or repairing piping, and provides standard methods of inspection and test.

The inch-millimeter conversion ratio of 25.4, recommended for adoption as a national standard for industrial use by the National Conference under the auspices of the A.S.A. has just been approved as an American Standard.

COMING MEETINGS

Sixth Midwest Engineering & Power Exposition—Stevens Hotel, Chicago, Ill. during "Engineering Week," June 27-29, of the Century of Progress Exposition. Headquarters, 308 W. Washington St., Chicago, Ill.

American Society for Testing Materials—Annual Meeting, The Stevens, Chicago, Ill., June 26-30. C. L. Warwick, Sec.-Treas., 1315 Spruce St., Philadelphia, Pa.

Nat'l Ass'n Power Engineers — National Convention, in conjunction with Niagara Frontier Power Conference & Mechanical Exposition, Buffalo, N. Y. Auditorium, Aug. 28—Sept. 2. Fred W. Rayen, Secretary, 1140 Lake St., Oak Park, Ill.

A.S.M.E. Oil & Gas Power Div.—6th National conference, Ritz-Carlton Hotel, Atlantic City, N. J., Aug. 23-26. Louis R. Ford, chairman, 29 West 39th St., New York City.

Canadian Electrical Ass'n — 43rd Annual Convention, June 14-16, Log Chateau, Lucerne-in-Quebec, Canada.

Second American Exposition of Brewing Machinery, Materials & Products—Auditorium Hotel, Chicago, Ill., Sept. 23—Oct. 1, together with meeting of Master Brewers Ass'n of America. James R. Nicholson, 55 West 42nd St., New York, N. Y., secretary. Felix Mendelsohn, managing director of exhibit.

Second National Lubrication Engineering Meeting—Penn. State College, May 25-26, under auspices A.S.M.E. and the College. Headquarters at Nittany Lion Inn. Details: Prof. F. G. Hechler, Penn. State College, State College, Pa.

American Boiler Mfrs. Ass'n—45th annual convention, Skytop Lodge, Skytop, Pa., June 5-7. A. C. Baker, secretary, 709 Rockefeller Bldg., Cleveland, Ohio.

Amer. Soc. Htg. & Vtltg. Engrs.—Semi-annual meeting, Hotel Statler, Detroit, Mich., June 22-24. Secretary, 51 Madison Ave., New York, N. Y.

Joint Conference on Coordination and Control of All Prime Movers—At Woodward Governor Co., Rockford, Ill., June 20-23. An outgrowth of annual conferences on water-power control of which this is sixth. Details: Irl C. Martin, above address.

Conn. State Ass'n Power Engineers—38th annual convention and exhibition, Hotel Green, Danbury, Conn., June 9-10. Geo. F. Klopfer, secretary, 70 Girard Ave., New Haven, Conn.

News Notes

The American Society of Heating and Ventilating Engineers, by a vote of 267 to 4, has adopted a new constitution and by-laws which is in a large measure a revision and enlargement of the previous constitution.

The New York Chapter of the National Association of Practical Refrigerating Engineers will hold its May 9 meeting at 243 East 84th St., New York City. A special speaker is scheduled. The previous meeting was April 21.

New York Public Library, Fifth Ave. & 42nd St., New York City, does not have copies of *Power* for August and October, 1932. Since the *Power* supply of extra copies is exhausted, we are unable to be of assistance. Therefore, if readers who no longer need their copies for these dates can send them to the Library the courtesy will be appreciated by the Library and by *Power* as well.

The Hydro Electric Power Commission of Ontario has announced a new policy of installation of electric water heaters in Ontario homes at no cost to the consumer. The outlay in material and labor in manufacture will be approximately $1,250,000 and heaters will use about 1 hp. of electrical energy, thus increasing load on the hydro systems by about 50,000 hp. and reaching eventually 100,000 hp.

PERSONALS

R. E. HELLMUND has been appointed chief engineer of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. He is the first Westinghouse executive to hold this office since the death of B. G. Lamme in 1924.

C. E. BALES, vice-president, The Ironton Ohio Fire Brick Co., gave an illustrated lecture on "Boiler Furnace Refractories" before the First Class Engineers Association of Ontario, May 2 in the Prince Edward Hotel in Windsor.

T. K. MIAL, regional vice-president of the Johns-Manville Corp., has been appointed an executive vice-president of the company. He will be general sales manager of the power products department. J. O. O'Brien has been appointed assistant general sales manager for the department.

ROY C. MUIR, for three years assistant to the late Charles E. Eveleth, vice-president in charge of engineering, General Electric Co., Schenectady, has been appointed manager of the department.

FRANK C. RUSSELL is organizing a division of the Standard Lime & Stone Co., to be known as the Rock Wool Insulation division. He was formerly president of the Mineral Felt Insulating Co., Toledo, Ohio.

BUSINESS NOTES

W. H. & L. D. BETZ, chemical engineers at 3701 N. Broad St., Philadelphia, have opened branch offices at 50 Church St., New York City, in charge of Gerald C. Walker, formerly of Baltimore. The company applies organic colloids to conditioning of boiler feedwater.

GENERAL AIR CONDITIONING CO., INC., 155 East 44th St., New York City, has been formed by M. Hitchen president, and A. H. Clogston, vice-president, both former executives of the Cooling & Air Conditioning Corp. David H. Knowles is secretary of the new organization. The company will offer complete engineering service in the design and installation of all classes of industrial air conditioning, air cooling and drying systems, as well as for the correct application of apparatus to such systems.

NORTHERN EQUIPMENT CO., Erie, Pa., has appointed the J. W. Murphy Co., 431 S. Dearnborn St., Chicago, as district representative.

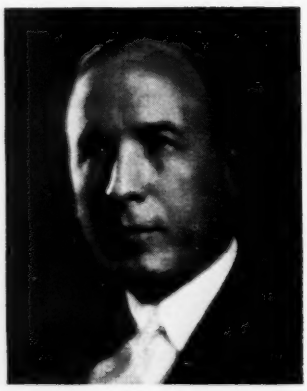
THOMAS A. MARSH has become a partner in the Ernest E. Lee Co., 115 S. Dearborn St., Chicago, Ill., manufacturers' representatives. He was for ten years chief engineer of the Green Engineering Co., for seven years western engineer for Combustion Engineering Corp., and for three years president of Modern Coal Burner Co.

CHAIN BELT CO., Milwaukee, has appointed Keller Tractor & Equipment Co., Inc., of Detroit, as distributor in that district.

AMERICAN DRYICE CORP. has taken over the business of Dryice Corp. of America, with offices at 205 East 42nd St., New York City. Warehouses will be maintained in all principal cities. F. A. Rogers is president, and E. R. Lawrence, vice-president and treasurer.

DUNBAR ENGINEERING CO. has appointed Washington Engineering Co., 601—13th St., N. W., Washington, D. C., as representative for Edward valves in the District of Columbia.

MAINTENANCE ENGINEERING CORP., 1400-2 Conti St., Houston, Tex., has been appointed to represent Ashton Valve Co., Boston, Mass., in the Gulf Coast area, with a stock in Houston.



W. P. THOMAS
New President of Diamond Power Specialty Corp., Detroit, as reported in *Power* for April

EDWARD E. ASHLEY, who planned the Pau Corp. steam-diesel installation at Union Stockyards, Chicago (*Power*, Dec., 1932) has opened an office at 10 East 40th St., New York City, to carry on a general practice in mechanical, electrical and sanitary engineering.

DANIEL W. MEAD and CHARLES V. SEASTONE have announced that their engineering business will be conducted by their successors, Harold W. Mead, Clayton N. Ward, and Henry J. Hunt, former associates, who will continue the business at the State Journal Bldg., Madison, Wis., under the name of Mead, Ward & Hunt, with Clayton N. Ward as chief engineer. Daniel Mead and Mr. Seastone will continue with the firm in advisory capacities.

E. J. LAVINO & CO., refractories division, Oliver Bldg., Pittsburgh, Pa., has moved its general sales and engineering departments from Philadelphia to Pittsburgh.

BLAISDELL-FOLZ EQUIPMENT CO. will represent Chain Belt Co. in the Cincinnati district. Offices are at 219 West Pearl St.

MORRIS MACHINE WORKS, Baldwinsville, N. Y., has moved its New York office to 254 West 31st St.

STEIN-BRILL CORP., machinery and equipment dealers, has moved to 183 Varick St., New York City.

GAS BURNER CORP., P. O. Box 321, Fort Worth, Tex., has been formed by Scott B. Lackland, president, Nolan B. Ritter, first vice-president, and Eugene Ritter, chief consulting engineer, to handle engineering and sales on the Ritter gas burner.

YORK ICE MACHINERY CORP., York, Pa., has established a commercial division to market new commercial refrigeration and air conditioning units, with C. A. Pearson as manager, under S. E. Lauer, general sales manager of the corporation.

REPUBLIC STEEL CORP. has moved its Dallas, Tex., sales office to 2322 Gulf Bldg., Houston, with R. E. Lanier, district sales manager, in charge.

ELLIOTT CO., Jeanette, Pa., has taken over Pacific Coast tube cleaner business of both Lagonda Mfg. Co. and Liberty Mfg. Co., subsidiary organizations, in the past handled through a sales agency. F. A. Calmus is Pacific Coast manager, with offices at 813 Rialto Bldg., San Francisco, Calif. Warehouse in Los Angeles at 1732 East 7th St., and in Seattle, Wash., at 414 Vance Bldg.

RILEY ENGINEERING & SUPPLY CO., LTD., Miranda & Schell Aves., Toronto, Ont., Canada, has been licensed by Bell & Gossett Co., 3000 Wallace St., Chicago, to manufacture and distribute B. & G. products exclusively throughout Canada. Riley Engineering is a subsidiary of Riley Stoker Co. and S. A. Armstrong, vice-president of Riley Stoker, is president.

NORTHERN EQUIPMENT CO., Erie, Pa., has appointed Geo. W. Neale as district representative for the State of Florida, except Jefferson County and counties west thereof. His office is at 504 East Lafayette St., Tampa.

DOUGHERTY & BACHRAN, 602 North American Bldg., Philadelphia, Pa., have resumed their former partnership in the general piping and contracting business.

DIESEL POWER ENGINEERING SCHOOL has moved to 3320 20th St., San Francisco, Calif.

BITUMINOUS COAL RESEARCH, INC., has been chartered under the Delaware law. This is the organization developed by the Research Committee of the National Coal Association, headed by John C. Cosgrove, Johnstown, Pa. According to present plans, technical research work will be conducted at Battelle Memorial Institute, Columbus, Ohio.

JOHN A. ROEBLING'S SONS CO., New York, has moved its office from 83 Liberty St. to 107 Liberty St., Robinson Bldg.

SUPERHEATER CO., 60 East 42nd St., New York City, has moved its Pittsburgh office to American Bank Bldg., 600 Grant St.

ROCKFORD ELECTRIC EQUIPMENT CO., Rockford, Ill., has opened a new plant at 720 S. Wyman St., devoted to buying, selling, repairing and exchanging of electrical and power apparatus of all kinds. A. J. Rund is president, S. J. Beishir, vice-president, D. T. Dwyer, secretary-treasurer.

OBITUARIES

ROBERT H. BEAUMONT, 60, president of the board of Robert H. Beaumont Co., Inc., Philadelphia, Pa., died recently in his home there. He organized the firm in 1905.

THOMAS CLARKSON, best known as inventor of the Clarkson waste heat boiler, died April 3 at Hollington, St. Leonard's on Sea, England. He was a member of the Institution of Mechanical Engineers from 1891 to the time of his death.

JAMES W. FLEMING, 63, for the past fifteen years chief engineer of the Mexican Petroleum Co., Chelsea, Mass., died there April 13.

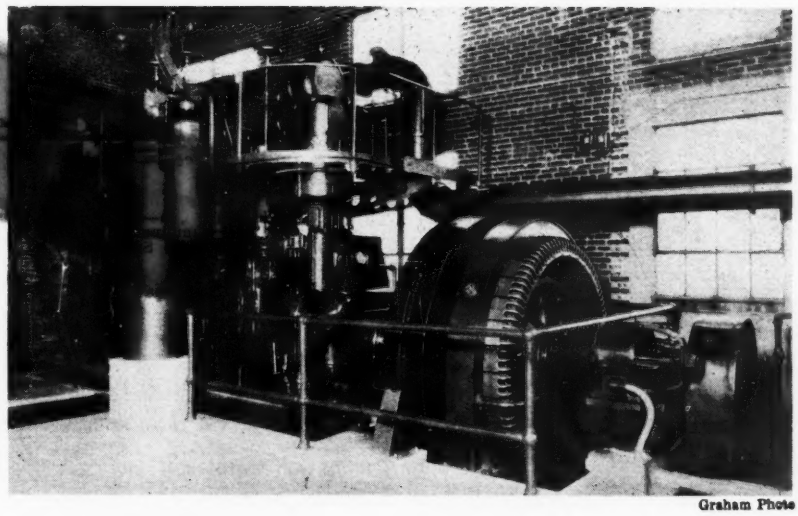
WILLIAM T. GOULD, 52, past president of the New England System Operators Club and electrical superintendent of Edgar Generating Station of Edison Electric Illuminating Co., Boston, died of pneumonia April 24, in Wollaston, Mass. He had been with the company for the past 29 years.

J. WM. LINK, for many years chief hydraulic engineer of Byllesby Engineering & Management Corp., Chicago, Ill., died April 14 after a long illness.

ARTHUR L. MERRIAM, 83, with Ames Iron Works, Oswego, N. Y., from 1872 until his retirement in 1919, and who was president and chairman of the board from incorporation in 1901 until his retirement in 1919, died April 25 of an embolism.

HAROLD WHITMORE SMITH, until June, 1932, generating apparatus manager of Westinghouse Electric & Mfg. Co., died in Pittsburgh, March 28, after a brief illness.

L. PHILIP COLLETTE, plant superintendent of the Central Maine Power Co. at the Wyman development near Bingham, Me., was drowned in the tail-race at that station May 1, by the overturning of a canoe in which he with several other had been fishing. The craft got too close to the draft tube discharge outlet and was sucked into the pool. Mr. Collette had been with the company for about eight years and was in charge of the electrical construction work at the Wyman development, Maxcy's substation, Deer Rips and Androscoggin No. 3 improvements.



Graham Photo

Winterset, Iowa, replaced its steam-engine-driven light plant with this diesel generator set in 1930 and more than doubled its profits. While steam fuel had cost 1.83 cents per kw.-hr. in 1929, diesel fuel costs have run around 0.4 cents per kw.-hr. In the year ending March 1, 1933, the plant was operated 4,487 hours. Fuel cost was $2,349.22, lubricating oil $179.28, and 578,330 kw.-hr. were generated. This gives a fuel cost of 0.406 cents per kw.-hr., lube oil cost of 0.03 cents per kw.-hr., and engine repairs are reported as 0.004 cents per kw.-hr. The engine is a McIntosh & Seymour, driving a G.E. generator.

STRAWS

Pointing the way the business wind blows

The Department of Hydraulics, Olympia, Wash., Charles J. Bartholet, supervisor, has issued preliminary permits for a total of 17 hydro-electric projects in various parts of the State, totaling more than 1,100,000 hp. (theoretical), with an aggregate estimated investment of over $81,500,000. One prominent development is that of E. W. Backus, head of Backus-Brooks, Co., Minneapolis, Minn., on the Cowlitz River, where it is proposed to construct a hydro-electric generating plant of about 102,000 hp., costing approximately $20,000 with transmission system. Another is that of R. M. Hardy for a project on the Klickitat River, of 23,750 hp., to cost $1,250,000.

Winchester, Va., P. P. Pilcher, city manager, will receive bids until May 12 for prime movers and other equipment for a municipal electric light and power plant, and distributing system. Diesel engine-generator units are to be used.

Sioux Falls, S. D., has purchased a 1,200-hp. Nordberg diesel direct-connected to an Allis-Chalmers generator for its new municipal light plant.

Seattle, Wash., is endeavoring to obtain $18,500,000 from the R.F.C. for the Ruby Dam project on the upper Skagit River, which includes completion of the Diablo power house.

Danville, Va., has surveys nearing completion for a proposed hydro-electric generating plant on the Dan River, to furnish service to Danville, Stuart, Martinsville, and other neighboring communities. It is expected to cost about $2,500,000, including transmission system.

National Aluminate Corp., Chicago, has awarded a contract to Strobel & Hall for an addition to its factory in Clearing, Ill., to increase floor space by 40 per cent.

Atlantic Pipe Line Co. has ordered seven 340-hp. Cooper-Bessemer diesels for its pipe line pumping stations, to replace purchased power.

Clay County Ice Co., Corning, Ark., has installed a 120-hp. Fairbanks-Morse diesel, which will also supply electricity to the town.

Allerton House, New York City, has purchased a Lister 18-hp. diesel engine to drive a refrigerating compressor. It is automatically controlled, and, according to Peet & Powers, consultants, will repay its cost in one year over purchased power.

Culpepper, Va., has voted a $120,000 bond issue for a municipal power-plant and distribution system. Taxpayers will not be liable for the expense, to be borne from revenue of the plant. Fairbanks-Morse Co. has offered to buy the present distribution system, or to build a new one, the cost of either proposal to be included in the bond issue.

Lynchburg and Covington, Va., are planning municipal power plants.

West Kootenay Power & Light Co.'s hydro-electric development, at Goat River Canyon, near Creston, B. C., has progressed to a point where the foundation for the cement dam is now completed. Construction of the power house is expected to begin soon.

Somerset Crushing Co., Bernardville, N. J., has ordered a 200-hp. Atlas-Imperial diesel for its crushing and screening plant, driving a generator by cog belt. The engine is a 9x10½-in., 500-r.p.m. unit.

Big Slide Mining & Developing Co., Ltd., 342 West Pender St., Vancouver, B. C., is planning to spend $20,000 in development of a small hydro-electric project to have an initial capacity of 350 hp., to be located at the junction of Kelley Creek with Fraser River.

Golden Center Mine, Grass Valley, Calif., has purchased a 600-hp. McIntosh & Seymour diesel connected directly to a General Electric a.c. generator. The unit, which operates at 240 r.p.m., will supply power for pumps, air drills, and hoists.

Washington Mills Co., Fries, Va., has awarded a contract to Mill & Marine Electric Co. for complete electrification of the unit at Fries, and to install a 4,000-hp. hydro-electric plant. Work is to be begun at once.

Urbana, Ill., has called a special election on May 9 to approve a fund of $650,000 for construction of a municipal electric light and power plant, including distribution system. A list of equipment to be installed has been arranged and early purchase is planned, following favorable vote. Warren & Van Pragg, Milliken Bldg., Decatur, Ill., are consulting engineers.

A bill has been introduced in the South Carolina State Senate to authorize a $30,000,000 to $50,000,000 project for development of the Santee and Cooper Rivers in coastal South Carolina. Plans include power dams, two reservoir lakes in Berkeley County, a 10-ft. ship canal 100 miles long, and reclamation of approximately 200,000 acres of alluvial soil.

The Rocky Mountain Power Co. has been granted a one-year extension of time on the Flathead project. The amended license requires that three units of not less than 150,000 hp. aggregate capacity be completed on or before May 23, 1935.

Black & Veatch, Mutual Building, Kansas City, Mo., consulting engineers, have been engaged to make surveys and estimates of cost for the new hydro-electric generating plant and irrigation project on the Loup River, near Ord, Nebr. C. A. Sorensen, Lincoln, Nebr., is forming a company to carry out the development, which will represent an investment of more than a half million dollars.

The Federal Power Commission has denied the application of Carl G. Stifel for preliminary permit for a proposed power project on the Mississippi River at Chain of Rocks in the vicinity of St. Louis, Mo. The denial was based, among other things, on the report of the Chief of Engineers of the War Department, who said that the development would have an adverse effect on navigation and would aggravate flood conditions, and would cause silting. Nearby municipalities also protested.

Bureau of Power & Light, Los Angeles, Calif., will purchase about 8,585,000 ft. of cable for the 275,000-volt transmission line from the city to Hoover Dam.

New Bulletins

CLEAN BOILERS—"A Clean Boiler Story," new 24-page bulletin of Hagan Corp., Pittsburgh, Pa., describes how boilers in many plants are kept in continuous service for long periods by maintaining them free from scale, corrosion, wet steam, etc. Installations described are of different types and operate under widely varying conditions throughout the United States and Canada.

GAS PUMPS—Bulletin 31-B11 of Roots-Connersville-Wilbraham, Connersville, Ind., describes the Types XA and XAS gas pumps for process service. Bulletin 100-B-11 illustrates and describes several R-C-W vacuum-blowing cleaner units. Bulletin 21-B15 describes aeration of ice cans in raw water ice plants, using R-C-W blower units.

VIBRATION AND PRESSURE MEASUREMENT—P. J. Kipp & Zonen, Postbox 7, Delft, Holland, have issued a series of bulletins describing the Moll vibration galvanometer, standard apparatus for producing and measuring high pressure, and the F/2 Spectograph.

COMBUSTION CONTROL—Bulletin No. M-56 of L. J. Wing Mfg. Co., 154 W. 14th St., New York, N. Y., is entitled "Better Heating from Low Cost Coal with a Wing Combustion Control System."

PUMPS—Rumsey Pump Co., Ltd., Seneca Falls, N. Y., has issued 96-page Catalog H-32 describing its complete line of pumps.

FEED WATER—"Treatment of Feedwater for High-Pressure Boilers" by C. E. Joos, chemical engineer, Cochrane Corp., Philadelphia, Pa., has been reprinted from *Combustion* for August, 1932, and is available from the company.

AUTOMATIC CONTROL—Bulletin No. 175 of The Foxboro Co., Foxboro, Mass., describes in its 32 pages the theory, operation and construction of the "Stabilog" system of automatic control and its application to temperature, pressure, liquid level and flow control.

CYLINDER-GUIDED EXPANSION JOINTS—Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., has issued Bulletin EJ-1904 on the Yarway "Gun-Pakt" Cylinder-Guided Expansion Joint. Described in *Power* in November, 1932.

PREHEATERS—Bulletin No. 332 of the Air Preheater Corp., 40 E. 34th St., New York, N. Y., describes the Ljungstrom air preheater and shows some typical applications in its 75 pages.

MULTIPLE-RETORT STOKERS — Detroit Stoker Co., General Motors Bldg., Detroit, Mich., issued a 12-page bulletin covering Detroit multiple-retort stokers described recently in *Power*.

FUSE LINKS—General Electric Co., Schenectady, N. Y., has issued GEA 1521-A, superseding GEA 1521, describing low-temperature fuse links.

FIRE HOSE—Two circulars on its new flat cured fire hose have been issued by the B. F. Goodrich Rubber Co., Akron, Ohio. One is "The Fire Hose That Folds," the other is "The New Fire Hose Is Flat."

SYNCHRONOUS MOTORS—General Electric Co. has issued a 54-page catalog on its line of synchronous motors and also GEA-1659 describing GE electric steam generators.

GASOLINE ENGINES—Sterling Engine Co., Buffalo, N. Y., has issued a new catalog on Sterling "Petrel" engines for truck, bus and industrial service.

ELEVATOR CABLE EQUALIZER—John W. Kiesling & Son, Inc., 1793-1803 Atlantic Ave., Brooklyn, N. Y., has issued a pamphlet describing the company's "All-Steel" elevator cable equalizer.

FOOT-OPERATED VALVE—W. H. Nicholson & Co., Wilkes-Barre, Pa., has issued Bulletin No. 1132 covering the company's new foot-operated three and four-way valves.

MONEL METAL—"Engineering Properties of Monel Metal" is the title of Bulletin T-5 of the Development and Research Department, International Nickel Co., Inc., 67 Wall St., New York, N. Y.

A-C MOTORS—Reliance Electric & Engineering Co., Cleveland, Ohio, has issued Bulletin 114 on Low-Inertia Special-Torque A-C Motors for quick acceleration, quick stopping, frequent and rapid reversing.

PAINT—New Jersey Zinc Sales Co., 160 Front St., New York, has issued a write-down of a technical paper by D. L. Gamble of the company's Research Division, entitled "Using Paint As Light," describing the effect of various colors and types of lighting on working efficiency.

New Plant Construction

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Ala., Sulligent — Municipality, sinking artesian well, 200 g.p.m. pumping plant, filter plant, 4½ mi. 2- to 8-in. c.i. mains, local labor, under supervision of R. L. Totten, engr., Homewood Station, Birmingham. Council to purchase materials. Work will not start until the Reconstruction Finance Corp. has passed on application for additional funds to finance construction of sewerage system, plans for which are pending.

Calif., Brawley—City, made agreement with Municipal Engr. Corp., 535 Van Nuys Bldg., Los Angeles, to construct diesel operated municipal light and power plant, incl. rein.-con. and steel building to house plant; 3,000 brake hp. capacity, 7,000 hp. ultimate capacity, designed to furnish 7,500,000 kw. energy per year, 750 kva. generators. Est. $500,000. Agreement provides that Company finance construction by issue of 20-year bonds to be retired from operation of the plant. E. J. Kingsbury, 222 South Hill St., Los Angeles, engr.

Calif., Madera—Hussey & Belcher, Syndicate Bldg., Oakland, preparing estimates of cost for diesel engine electric plant for lighting and power purposes, for city.

Calif., Visalia—City to have estimates of cost made to acquire privately-owned power plant and improve and operate same as municipal project.

Del., Brandywine Hundred—Wilmington Suburban Water Co., Edgemoor, making surveys preliminary to building 200,000 gal. water system with expected expansion to 400,000 gal. in Brandywine Hundred, north of Wilmington, equipment to consist of 3 electrically driven centrifugal 140 g.p.m. low and 3 electrically driven 140 g.p.m. high pressure pumps, two 100,000 gal. standpipes, 1½ mi. 8 in. mains. Water will be drawn from a 5 acre lake west of Philadelphia Pike, near Bellevue. Initial expenditure $260,000. S. N. Van Trump, pres.

Ill., Granite City—Voters approved proposal through which the city may establish municipal light and power plant, $750,000, and municipal waterworks and distribution system. Another election will be necessary to finally vote bonds to finance the projects.

Ill., North Chicago—City Council voted to request loan from Reconstruction Finance Corp. for municipal electric light plant. $42,500. Neiler, Rich & Co., 431 South Dearborn St., Chicago, engrs.

Ill., Springfield—City Comn. bids about May 30, 91x150 ft., power plant, 95 ft. high. $150,000. Burns & McDonnell Eng. Co., 406 Interstate Bldg., Kansas City, Mo., engrs.

Ind., Auburn—City made survey for improvements at waterworks and electric light plant. $300,000. Froelich & Emery, Toledo, O., engrs.

Ind., Brazil—City, election June 17, to vote on bonds, light plant. Preliminary reports complete. Burns & McDonnell Eng. Co., 400 Interstate Bldg., Kansas City, Mo., engrs.

Ind., Goshen—City plans electrification of water pumping system and installing new wells at City Light and Water Plant. $50,000. Reconstruction Finance Corp. loan applied for.

Ky., Middlesborough—City, c/o City Clerk, sketches municipal light plant and equipment, etc. $300,000.

Ind., Rockville—City, T. K. Hayes, clk., bids about May 20, water and light plant, incl. two 250 hp. boilers, one 250 kw. and one 150 kw. generators, also motor-driven pumps. $45,000. J. M. Rotz, 817 Merchants Bank Bldg., Indianapolis, engr.

Ky., Flemingsburg—City bids probably in June, filtration and pumping plants, 300 g.p.m. capacity, 100,000 gal. tank on tower, 5 mi. 2- to 8-in. c.i. pipe, 33 ft. within dam and impounding reservoir, 32 m.g. with gravity flow through 1,300 ft. 8 in. supply line to filters in city. $75,000. H. K. Bell, Lexington, engr.

Ky., Fort Thomas—City sketches light plant and distributing system. Burns & McDonnell Eng. Co., 406 Interstate Bldg., Kansas City, Mo., engrs.

Mich., Albion—City, W. C. Dean, chn. Com., preliminary plans completed for electric power plant. $565,000. Burns & McDonnell Eng. Co., Interstate Bldg., Kansas City, Mo., engrs. Generating equipment to be driven by Diesel engines.

Mich., Carrollton—Village plans prepared water distributing system, incl. pumps, basin and pipe lines. $112,000. Francis Eng. Co., Eddy Bldg., Saginaw, engrs.

Mich., North... ...ns water filtration ... ...0,000. Boulay Harrison ... ..., Toledo, O., engrs.

Minn., Morris— ...ity plans power plant. $150,000. ... Torrens, 630 Shubert Bldg., St. Paul, consult. engr.

N. J., Manville—C. J. Kupper, engr., 409 East Main St., Bound Brook, receiving competitive sketches 6 story, basement, 200x370 ft., steel, limestone, brewery and power plant, Main and Knopf Sts., for Great Eastern Brewery, Inc., Wilhonksey Bldg., Main St. and Champlain Rd. $1,000,000.

N. J., West Burlington—Public Serv. Electric & Gas Co., 80 Park Pl., Newark, plans an experimental generating plant. $40,000. Maturity indefinite. Private plans.

N. Y., Bath—Bd. Village Trustees plans repairing electric lighting plant. $75,000 voted.

N. C., Anderson—Appleton Co. plans rebuilding steam power plant and new equipment. $200,000.

N. C., Roanoke Rapids—City plans new pumping station, taking water from Roanoke River. Est. about $25,000. Spoon & Lewis, engrs., Box 244, Roanoke Rapids, making survey and preparing estimates.

O., Circleville—City Council adopted resolution declaring it necessary to employ engineer to make plans for municipal power plant.

O., Edgerton—City, preliminary plans hydro-electric plant and dam. Mayor now drawing up tentative proposal to obtain money from Reconstruction Finance Corp.

O., Kenton—City preliminary plans electric light and power plant. $30,000 or more. H. ... Jones, 2nd Natl. Bank Bldg., Toledo, engr.

O., Sandusky—City Comn. sketches municipal light plant. Froelich & Emery Eng. Co., ... Natl. Bank Bldg., Toledo, engrs.

Okla., Cushing—Municipality plans electric distribution plant. $300,000.

S. D., Groton—City plans municipal power plant. $53,460. J. M. Emberg, Madison, engr.

Tex., Plainview—City c/o R. P. Smyth, mayor, voted $450,000, complete power ... and distributing system, etc., incl. purchase complete set up of power machinery. Montgomery & Ward, Harvey-Snider Bldg., Wichita ... engrs.

Tex., Wichita Falls—City plans light ... power plant and distributing system. $100,000. Address V. R. Smithers, city mgr.

Utah, Salt Lake City—City Comrs. receive petition to take steps to put up to citizens question of municipally owned power plant and distribution system. $18,000,000. Bond ... to finance and to be refunded out of earnings. W. D. Beers, city engrs.

Va., Winchester—City Council soon ... bids municipal power plant, C. R. Anderson, mayor.

Wis., Hudson—City, G. R. Hosford, clk., plans municipal light and power plant. $200,000. P. R. Banister, North St. Paul, Minn., engr.

Equipment Wanted

DIESEL ENGINE GENERATOR PLANT—**Los Banos, Calif.**—City having estimates prepared for diesel engine generator plant for light and power plant.

GENERATORS—**Wash., D. C.**—May 26, by General Purchasing Officer, Wash., D. C., diesel engine driven generators.

STEAM TURBINE—**Fort Wayne, Ind.**—City Light & Power Co., Fort Wayne, soon takes bids high pressure steam turbine, 12,000-15,000 kva. designed for 3 new boilers being installed. $200,000. W. J. Hosey, mayor.

DIESEL ENGINE PLANT—**Taos Junction, N. M.**—New Mexico Gold Producers Corp., Taos Junction, plans installing 4 dredges and constructing 500 hp. diesel engine plant to operate dredges. H. M. Payne, 841 Munsey Bldg., Wash., D. C., engr. $80,000.